

FINAL SUBMITTAL

VOLUME I OF II

ENERGY SAVINGS OPPORTUNITY SURVEY FORT GILLEM, GEORGIA

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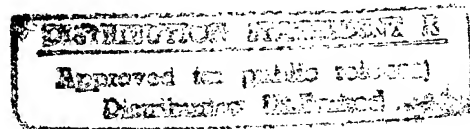
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CORPS OF ENGINEERS
SAVANNAH, GEORGIA

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LIST OF ABBREVIATIONS

ACH	-	air changes per hour
AAFES	-	Army Air Force Exchange Service
AHU	-	air handling unit
Bldg	-	building
cfm	-	cubic feet per minute
conf.	-	confirmation
DCU	-	digital control unit
DDC	-	direct digital control
DEH	-	Director of Engineering and Housing
DHW	-	domestic hot water
DX	-	direct expansion
ECIP	-	Energy Conservation Investment Program
ECO(s)	-	Energy Conservation Opportunity(ies)
ESOS	-	energy savings opportunity survey
F	-	Fahrenheit
FCU	-	fan coil unit
ft	-	foot, feet
FY	-	fiscal year
gpm	-	gallons per minute
hp	-	horsepower
HPS	-	high pressure sodium
hr	-	hour(s)
HW	-	hot water
in.	-	inch(es)
kVar	-	kilovolt amp reactive
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hour, one thousand watthours
LAPS	-	lighting automation panels
LBH	-	pounds per hour
lbm	-	pounds mass
LCCID	-	Life Cycle Cost in Design
MBtu	-	British thermal units (thousand)
mcf	-	thousand cubic feet

LIST OF ABBREVIATIONS

(Continued)

MCA	-	Military Construction Army Program
MCP	-	Military Construction Program
NAF	-	non-appropriated funds
PRV	-	pressure reducing valve
psia	-	pounds per square inch, absolute
psig	-	pounds per square inch, gauge
QRIP	-	Quick Return on Investment Program
RCU	-	remote control unit
rpm	-	revolutions per minute
SES	-	Shared Energy Savings
SIOH	-	supervision, inspection, and overhead
SIR	-	Savings-to-Investment Ratio
SOW	-	Scope of Work
therm	-	100,000 Btus
UCS	-	utility control system
UPW	-	uniform present worth

COMMANDER SUMMARY

PURPOSE OF STUDY

The purpose of the study was to analyze energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort Gillem, Georgia.

RESULTS

Of the individual ECOs evaluated, 12 ECOs had a savings-to-investment (SIR) ratio greater than 1.0. Those ECOs having an SIR greater than 1.0 are, by definition, economically feasible. The total estimated construction cost for the 12 ECOs is \$4,455,080.

The individual ECOs were grouped into projects for possible funding under three main funding areas: 1) Military Construction Army (MCA) program; 2) Low-cost, No-cost projects; and 3) Non-Appropriated Funds (NAF) projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1 - Included the following ECOs:
 - ECO 1, Add duct insulation
 - ECO 1, Add roof insulation
 - ECO 5, Install high efficiency electric motors
 - ECO 7, Control hot water circulation pumps
 - ECO 11, Replace street lights
 - ECO 12, Revise or repair HVAC controls
 - ECO 14, Provide infrared heaters
 - ECO 15, Separate (automatic) light switches
 - ECO 18, Replace exit sign bulbs with fluorescent bulb kits
- MCA Project 2 - ECO 19, Previous lighting study review, for light fixture replacement

ECO 8, install low flow shower and faucet fixtures, was evaluated as a low-cost, no-cost ECO to be performed by in-house maintenance staff.

Two ECOs were evaluated for NAF facilities funding:

- ECO 14, loading dock seals
- ECO 18, replace exit sign bulbs with fluorescent bulb kits

Table 1 on the following page summarizes the savings, costs, and project economics of the proposed projects. It is recommended the Army fund and implement construction of the energy conservation projects to lower facility utility consumption in order to meet the energy reduction goals of Executive Order 12759 of April 17, 1991.

TABLE 1
ECONOMIC PROJECT SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
MCA Project 1	86	974,092	6,671	9,994	56,008	8,843	(433)	64,418	735,360	1.1	11.4
MCA Project 2	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
Low-Cost/ No-Cost ECO	0	0	99	99	460	0	550	1,010	925	13.5	0.9
NAF ECO-14 Seals	0	100,073	3,829	4,170	20,433	0	0	20,433	102,705	4.5	5.0
NAF ECO-18	9	78,840	0	269	2,010	924	(906)	2,028	12,711	2.5	6.3
TOTAL	1,356	4,124,805	10,599	24,666	179,358	140,145	(789)	294,048	3,526,544	1.6	10.6

EXECUTIVE SUMMARY

PURPOSE OF STUDY

This study was conducted under Contract No. DACA21-91-C-0097, issued by the Corps of Engineers, Savannah District, in September 1991. The study analyzes energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort Gillem, Georgia.

ECOs EVALUATED

The 17 ECO projects identified in the SOW to be evaluated for selected buildings are listed in Table ES-1 on page ES-2.

During the entrance interview conference, ECO 18 was included. ECO 18, which converts incandescent exit sign light bulbs to fluorescent bulbs, was evaluated for all buildings specified for ECO 15, lighting controls.

Based on discussions with DEH, it was also decided to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results are included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

Subsequent to the field survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. A complete list of these ECOs, and the reasons they were eliminated, are included in Table ES-2 on page ES-3.

In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list.

Table ES-3 on page ES-4 contains a building-ECO matrix, indicating which ECOs are:

- Applicable and evaluated projects
- Not applicable and dropped from further evaluation
- Added as an applicable project.

TABLE ES-1
ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE ES-2
NONFEASIBLE ECOs

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
207	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
400	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
401	5	No motors 1 horsepower or larger
401	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
403	5	No motors 1 horsepower or larger
701-710, 198, 922, 923, 942	All ECOs	Buildings scheduled for demolition

TABLE ES-3
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
101	Administration	A	A	A	A	A	A	A		A			A	A*		A	A		A*	A*
102	Maintenance				A	A					A						A			A*
103	Fire Station				A	A										A	A		A*	A*
133	Officers Club				A	A				A							A			A*
207	Storage	A*	A*	A*	A	A					A				A	A	A		A*	A*
213	CID Building				A	A										A	A		A*	A*
214	Commissary				A	A									A		A			A*
308	Storage				A	A											A			A*
400	DOL				A	A					A				A	A	A		A*	A*
401	Eighty-first Arc.				A	N					A				N	A	A		A*	A*
403	Dining Facility				A	N											A	A		A*
505	Storage				A	A											A	A		A*
506	Storage																A	A		A*
507	Storage																A	A		A*
508	Storage																A	A		A*
509	Storage																A	A		A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

TABLE ES-3
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
510	Storage																A	A		A*
511	Storage																A	A		A*
512	Storage {1}	A	A	A	A	A				A					A	A	A		A*	A*
513	Storage																A	A		A*
514	Storage																A	A		A*
735	Theater (T)	A	A	A	A	A											A			A*
935	Fitness Center				A	A		A*								A	A		A*	A*

{1} Representative of Buildings 505 through 514

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

RESULTS

Of the individual ECOs evaluated, 12 projects had an SIR greater than 1.0 (see Table ES-5 on page ES-9). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total estimated construction cost for the 12 projects is \$4,455,080.

Table ES-4 on page ES-7 lists the economic summary of each individual ECO, in ECO number order. Table ES-5 on page ES-9 lists the economic summary of each individual ECO, in order by SIR.

All ECOs determined to have an SIR less than 1.0 should be dropped from further analysis. These include:

- - ECO 1, Pipe Insulation
 - ECO 1, Wall Insulation
 - ECO 2, Insulated Windows
 - ECO 3, Weatherstripping and Caulking
 - ECO 6, Economizers
 - ECO 9, Heat Reclaim from Hot Refrigerant Gas
 - ECO 10, Prevent Air Stratification
 - ECO 13, Thermal Storage

TABLE ES-4
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
1-Pipe Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking		NO BUILDINGS WITH SIR GREATER THAN 1.0									
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
8-Shower/Faucet	0	0	99	99	460	0	550	1,010	925	13.5	0.9
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
14-IR Heaters	0	1,692,360	14,452	20,228	110,647	0	0	110,647	1,064,948	1.4	9.6
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2

TABLE ES-4
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

(CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
16-Demand		NOT APPLICABLE									
17-Boiler		NOT APPLICABLE									
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

**TABLE ES-5
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR**

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	99	99	460	0	550	1,010	925	13.5	0.9
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
14-IR Heaters	0	1,692,360	14,452	20,228	110,647	0	0	110,647	1,064,948	1.4	9.6
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
TOTAL	1,365	5,637,596	26,527	45,757	267,791	140,145	(963)	406,773	4,452,398		
4-HW Temp		NOT APPLICABLE									
1-Pipe Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									

TABLE ES-5
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

(CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kW/h)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
17-Boiler		NOT APPLICABLE									
16-Demand		NOT APPLICABLE									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									

ENERGY PROJECT DEVELOPMENT

The individual ECOs were grouped into projects for possible funding under three main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Following the Interim Submittal, Fort McPherson DEH provided EMC with a list of buildings which have reimbursed utilities (NAF buildings) at Ft. Gillem. These facilities were eliminated from the possible ECIP funded projects. The Interim Submittal recommended ECIP projects were revised to take into account lower individual ECO construction cost estimates due to the elimination of these facilities.

At Fort Gillem, no projects were evaluated for ECIP funding because the construction cost of all combined economically feasible projects was less than \$300,000.

At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1 - Includes the following ECOs:
 - ECO 1, Add duct insulation
 - ECO 1, Add roof insulation
 - ECO 5, Install high efficiency electric motors
 - ECO 7, Control hot water circulation pumps
 - ECO 11, Replace street lights
 - ECO 12, Revise or repair HVAC controls
 - ECO 14, Provide infrared heaters
 - ECO 15, Separate (automatic) light switches
 - ECO 18, Replace exit signs bulbs with fluorescent bulb kits
- MCA Project 2 - ECO 19, Previous lighting study review, for light fixture replacement

ECO 8, install low flow shower and faucet fixtures, was evaluated as a low cost, no cost ECO to be done with in-house maintenance staff.

ECOs evaluated for NAF facilities which have an SIR greater than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

Table ES-6 on page ES-12 provides an economic summary of ECO projects which should be considered for funding. Overall, there are \$3,124,931 of potential Non-ECIP ECO projects, and \$115,416 of potential NAF projects to fund.

TABLE ES-6
ECONOMIC PROJECT SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
MCA Project 1	86	974,092	6,671	9,994	56,008	8,843	(433)	64,418	735,360	1.1	11.4
MCA Project 2	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
Low-Cost/ No-Cost ECO	0	0	99	99	460	0	550	1,010	925	13.5	0.9
NAF ECO-14 Seals	0	100,073	3,829	4,170	20,433	0	0	20,433	102,705	4.5	5.0
NAF ECO-18	9	78,840	0	269	2,010	924	(906)	2,028	12,711	2.5	6.3
TOTAL	1,356	4,124,805	10,599	24,666	179,358	140,145	(789)	294,048	3,526,544		

RECOMMENDATIONS

- It is recommended the Army fund the construction of the two MCA projects to lower facility utility consumption in order to meet energy reduction goals of the Department of Defense.
- It is recommended Fort Gillem DEH complete the low-flow shower and faucet fixture project (ECO-8) in-house, using operation and maintenance money and local government staff.
- It is recommended the results of the energy evaluations on NAF buildings be provided to the related organizations for possible funding.

ENERGY CONSUMPTION

Electricity, natural gas, and water and sewer use will be conserved if the ECOs identified in this study are implemented.

Electrical energy consumption for FY90 and FY91 is tabulated in Table ES-7 on page ES-14. The average monthly electrical consumption varies from a minimum of 1,896,000 kWh in February, to a maximum of 3,048,000 kWh in August.

Natural gas consumption for FY90 and FY91 is tabulated in Table ES-8 on page ES-15. The average monthly natural gas consumption varies from a minimum of 12,437 therms in July, to a maximum of 300,308 therms in March.

**TABLE ES-7
ELECTRICAL ENERGY CONSUMPTION
FORT GILLEM**

Month	Post-wide Electrical Consumpt. kWh, FY90	Post-wide Electrical Consumpt. kWh, FY91	Post-wide Electrical Consumpt. kWh Avg. 90/91
Oct.	2,035,200	2,304,000	2,169,600
Nov.	1,737,600	2,054,400	1,896,000
Dec.	2,131,200	2,102,400	2,116,800
Jan.	2,409,600	2,150,400	2,280,000
Feb.	1,920,000	2,227,200	2,073,600
March	2,121,600	1,958,400	2,040,000
April	1,920,000	2,112,000	2,016,000
May	2,236,800	2,140,800	2,188,800
June	2,707,200	2,649,600	2,678,400
July	2,755,200	2,793,600	2,774,400
Aug.	3,081,600	3,014,400	3,048,000
Sept.	2,515,200	2,544,000	2,529,600
TOTAL	27,571,200	28,051,200	27,811,200

**TABLE ES-8
NATURAL GAS CONSUMPTION
FORT GILLEM**

Month	Post-wide Natural Gas Consumption (Therms - FY90)	Post-wide Natural Gas Consumption (Therms - FY91)	Post-wide Natural Gas Consumption (Therms - Avg.)
Oct.	57,815	54,080	55,948
Nov.	155,197	124,669	139,933
Dec.	365,521	235,094	300,308
Jan.	209,241	299,628	254,435
Feb.	139,875	206,257	173,066
March	113,897	135,811	124,854
April	72,354	36,386	54,370
May	14,396	17,102	15,749
June	12,782	13,485	13,134
July	12,381	12,493	12,437
Aug.	13,431	13,182	13,307
Sept.	13,013	15,507	14,260
TOTAL	1,179,903	1,163,694	1,171,798

The percentage comparison of historical consumption and cost for electricity and natural gas are tabulated in Table ES-9 below. Table ES-10 below provides a comparison of the percent of energy and dollars saved after the ECOs recommended are implemented.

**TABLE ES-9
FY91 UTILITY USAGE AND COST COMPARISON**

UTILITY	CONSUMPTION FY91		COST FY91	
	(MBtu)	(%)	(\$)	(%)
Electricity	95,739	45	1,470,583	70
Natural Gas	116,369	55	644,169	30
Total	212,108	100	2,114,752	100

**TABLE ES-10
PERCENT ENERGY AND DOLLAR SAVINGS**

UTILITY	ENERGY SAVINGS			DOLLAR SAVINGS		
	Base Energy (MBtu)	Energy Savings (MBtu)	Percent Savings (%)	Base Energy (\$)	Energy Savings (\$)	Percent Savings (%)
Electricity	95,739	18,740	19.6	1,470,583	140,015	9.5
Natural Gas	116,369	21,972	18.9	644,169	102,609	15.9
Total	212,108	40,712	19.2	2,114,752	242,624	11.5

SECTION 1.0

INTRODUCTION

1.1 AUTHORITY FOR STUDY

This study was conducted under Contract No. DACA21-91-C-0097, issued by the U.S. Army Corps of Engineers, Savannah District, in September 1991.

1.2 PURPOSE OF STUDY

The purpose of the study was to analyze energy requirements and energy conservation opportunities (ECOs) for selected buildings at Fort Gillem, Georgia.

1.3 SCOPE OF WORK

The scope of work (SOW) for this study is defined in the contract entitled "Energy Savings Opportunity Survey" (ESOS), dated 18 June 1991, and includes the following major tasks:

- Conduct a limited site survey to evaluate the ECOs in the selected buildings.
- Obtain the necessary data to evaluate.
- Identify which ECOs are technically feasible, including low cost or no cost ECOs.
- Calculate the energy and dollar savings, and prepare cost estimates for each ECO determined to be technically feasible.
- Calculate the simple payback and savings-to-investment ratio (SIR) for each ECO.
- Prepare an Interim Submittal which illustrates the methods, justifications, and calculations of the approaches taken.
- Present, at a review conference, the work accomplished to date showing energy and dollar savings, simple payback, and SIR of all technically feasible ECOs.
- Combine technically and economically feasible ECOs into packages (in coordination with installation personnel) which will qualify for Energy Conservation Investment Program (ECIP) or Military Construction Program (MCP) funding.

The complete SOW for this study and related Confirmation Notices are included in Appendix A of this Volume I. For convenience, Table 1-1, starting on page 1-4, presents a detailed list of items required by the SOW and indicates where those items are presented in this report.

1.4 ORGANIZATION OF SUBMITTAL

Volume I of this submittal includes the following:

- Sections 1.1 and 1.2 contain introductory information relevant to the study and the preparation of the report, based on the SOW outlined in Section 1.3. This Section 1.4 explains the organization of the report, while Section 1.5 describes the status of the study and the work remaining to complete the project. Section 1.6 describes previous energy studies at Fort Gillem.
- Section 2.0 describes the Fort Gillem utility rates and energy use for FY90 and FY91.
- Section 3.0 describes the ECOs evaluated, the analysis methodology, and the results of the ECO evaluations.
- Section 4.0 describes recommended energy conservation projects for future funding.
- Section 5.0 presents a summary of findings and recommendations.
- Appendices A through D provide backup calculations and contract documentation.

Volume II of this submittal includes the following:

- Appendix E includes computer simulations.
- Appendix F includes field survey notes.

1.5 WORK ACCOMPLISHED

With the completion of this Final Submittal the following items have been accomplished:

- Site survey.
- Entrance and exit interviews.
- Determination of base energy usage.
- Evaluation of ECOs.
- Calculation of ECO cost, annual energy savings, annual dollar savings, SIR, and simple payback period.
- Prioritization of ECOs by SIR.
- Preparation and delivery of Interim Submittal.

- Interim Submittal review conference.
- Update ECO projects, based on review comments.
- Combine technically and economically feasible ECOs into packages (in coordination with installation personnel) which will qualify for ECIP or MCP funding.
- Determine cost, annual energy savings, annual dollar savings, SIR, and simple payback period of the ECO packages.
- Prepare and deliver Prefinal Submittal.
- Prefinal Submittal review conference.
- Make revisions and corrections.
- Conduct an O&M briefing of the study results.
- Prepare and deliver Final Submittal.

TABLE 1-1
SCOPE OF WORK SUMMARY
ENERGY SAVINGS OPPORTUNITY SURVEY, FORT GILLEM, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
1	1 5	1.1 7.2	Perform limited site survey.	--
2	1	1.2	Evaluate ECOs to determine economic feasibility.	Volume I 3.0
3	1 6	1.3 7.3	Group recommended ECOs into projects for implementation.	Volume I 4.0
4	1	1.4	Prepare submittal.	-
5	1	2.3	As a minimum, evaluate ECOs listed in Annex A.	Volume I 3.2
6	2 5	2.3 7.2	Determine if ECOs are technically feasible. Document ECOs considered not feasible.	Volume I 3.2
7	2 5	2.6 7.1	Use current ECIP criteria in performing analysis.	Volume I 3.4
8	2	2.7	Combine ECOs into larger packages for ECIP or MCP funding.	Volume I 4.0
9	2	2.7.1	List and prioritize, by SIR, projects which qualify for ECIP funding.	Volume I Table 3-32
10	2	2.7.2	Prioritize, by SIR, feasible non-ECIP projects.	Volume I 4.3
11	4 5	5.1 7.1	Develop life cycle cost analysis summary sheets for ECIP projects.	Volume I Appendix C
12	4	5.1	Provide original backup calculations from previous studies.	Volume I Appendix C
13	4	5.2	Develop life cycle cost analysis summary sheets for non-ECIP projects.	Volume I Appendix D
14	4	5.3	Document nonfeasible ECOs in the report.	Volume I 3.2
15	5	7.1	Analyze the ECOs listed in Annex A.	Volume I 3.4

TABLE 1-1
SCOPE OF WORK SUMMARY (Continued)
ENERGY SAVINGS OPPORTUNITY SURVEY, FORT GILLEM, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
16	6	7.1.2	Prepare calculation, showing all numbers and assumptions.	Volume I Appendix C
17	5	7.1	Utilize computer simulations on specified ECOs.	Volume I Appendix C
18	5	7.2	Document site survey, and provide completed forms as part of the report.	Volume II Appendix F
19	5	7.2	Thoroughly evaluate and document all potential ECOs which are not eliminated.	Volume I Appendix C
20	6 Conf. Notice 2	7.4 No. 8	Prepare a comprehensive report.	Prefinal Submittal
21	6	7.4	Give a formal presentation of the results.	--
22	6	7.4.1	Interim Submittal - include analyses performed to date and results of field survey.	Interim Submittal
23	6	7.4.1	Interim Submittal - include copies of the Scope of Work and any modifications.	Volume I Appendix A
24	6	7.4.1	Interim Submittal - provide a narrative summary.	Executive Summary
25	6	7.4.1	Interim Submittal - include copies of field survey forms.	Volume II Appendix F
26	7 Conf. Notice 2	7.4.2 No. 5	Prefinal Submittal - document the integrated aspects of the study.	Volume I 4.0
27	7	7.4.2	Prefinal Submittal - include an order of priority, by SIR, for the recommended ECOs.	Volume I 4.0

TABLE 1-1
SCOPE OF WORK SUMMARY (Concluded)
ENERGY SAVINGS OPPORTUNITY SURVEY, FORT GILLEM, GEORGIA

ITEM NO.	SOW PAGE	SOW SECTION	DESCRIPTION	VOLUME SECTION
28	7	7.4.2	Prefinal Submittal - include an executive summary per Annex D.	Executive Summary
29	7	7.4.2	Prefinal Submittal - list all projects and ECOs developed in the study.	Volume I 4.0
30	7	7.4.3	Final Submittal - incorporate revisions and corrections resulting from comments.	Final Submittal
31	5	7.2	Use metering equipment with the proper accuracies and calibration.	Volume II Appendix F
32	E-1	--	Present an operational and maintenance briefing.	--
33	--	--	Computer simulation printouts will be provided.	Volume II Appendix E

1.6 PREVIOUS UTILITY CONSERVATION STUDIES

During the course of this ESOS study, EMC reviewed a number of utility conservation studies completed by other firms for Fort Gillem. These studies include:

- "Feasibility Study For Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem," prepared by Stone & Webster Engineering Corporation, July 1990.
- "Basewide Energy Systems Plan For Ft. Gillem," prepared by JRB Associates, July 1980.

The results of the shared energy savings lighting retrofit project were reevaluated and incorporated in this study (see Section 3.4.19). Where practical, some technical information presented in these reports was utilized in the preparation of this report.

SECTION 2.0

UTILITY CONSUMPTION AND RATES

2.1 GENERAL

Fort Gillem is located within the city limits of Forest Park in Clayton County, Georgia, approximately 10 miles south of the central business district of Atlanta. It is also in close proximity to other, smaller cities such as College Park, Morrow, and Lake City, Georgia, all located south of Atlanta. The post occupies 1,500 acres of land, and extends approximately 2.5 miles in length and 1.5 miles in width, from U.S. Highway 23 and State Highway 42 (Moreland Avenue) on the east and State Highway 54 (Jonesboro Road) on the west. As a submission of Fort McPherson, Fort Gillem supports the officially stated mission of Fort McPherson, plus provides support to the mission of major Government activities facilitated at Fort Gillem, including the Army Air Force Exchange Service (AAFES) Eastern Distribution Center.

Electricity, natural gas, and water and sewer use can be conserved by ECOs evaluated in this study. The rates and historical consumption of these utility sources are discussed in this Section.

Utility consumption and rate backup calculations are provided in Appendix B of this Volume.

2.2 UTILITY RATES

2.2.1 Electrical Rates

Electrical energy is supplied to Fort Gillem under Schedule G-10, Full Use Service to Government Institutions, from Georgia Power Company. The current rates and contracted amounts have been in effect since 4 December 1991. The electrical rate is broken down into five parts, as follows:

- Base charge
- Consumption (energy) charge
- Power factor charge
- Fuel cost recovery charge
- Minimum monthly billing.

Base Charge: The base charge is \$55 per month.

Consumption charge:

kWh less than 300 x billing demand	
Cost of first 50,000 kWh	\$0.0600 per kWh
Cost of next 150,000 kWh	\$0.0582 per kWh
Cost of next 800,000 kWh	\$0.0442 per kWh
Cost of over 1,000,000 kWh	\$0.0410 per kWh
kWh more than 300 x billing demand	\$0.0115 per kWh.

Billing demand is greatest of:

- (1) Current monthly actual demand
- (2) 95% of highest demand in previous June through September
- (3) 60% of highest demand in previous October through May.

Power factor charge:

Power factor < 95% \$0.27 per kVAR.

Currently, the power factor is above 95% and there has been no charge.

Fuel cost recovery charge:

Monthly adjustment x total kWh.

The fuel cost recovery rate is \$0.0140/kWh.

Minimum monthly bill:

\$55 base charge
+ \$8 per kW of billing demand (but not less than \$3,400)
+ power factor charge and fuel cost recovery.

2.2.2 Natural Gas Rates

Natural gas is supplied to Fort Gillem under rate N-16, Large Commercial Interruptible Service, from Atlanta Gas Light. The current rates and contracted amounts have been in effect since 1992. The natural gas rate is broken down into four parts, as follows:

- Monthly customer charge
- Firm use charge
- Consumption (energy) charge
- Gas adjustment charge.

Monthly customer charge: \$250.

Firm use charge: \$10,400 (Based on minimum daily availability of 8,000 therms at \$1.30.)

Consumption charge:

Monthly meter reading

(MCF) x 10.29 therms/MCF = therms

Cost of first 100,000 therms	\$0.070 per therm
Cost of next 200,000 therms	\$0.057 per therm
Cost of over 300,000 therms	\$0.047 per therm.

Gas adjustment charge:

Monthly adjustment x total therms.

The average gas adjustment charge for calendar years 1990 and 1991 was \$0.397/therm, which accounts for 67% of annual gas costs at Fort Gillem.

2.2.3 Water and Sewer Rates

The charges for water services from the Atlanta Water System include the following:

Water Charges

Cost of first 3 CCF (base charge)	\$3.35 total
Cost of next 67 CCF	\$1.70 per CCF
Cost of next 600 CCF	\$1.04 per CCF
Cost of over 670 CCF	\$0.72 per CCF.

The charges for sewage service from the City of Forest Park, separately metered from water, include the following:

Sewage Charges

Cost of first 2 gallons (base charge)	\$6.00 total
Cost over 2 gallons	1.95 per thousand gallons

2.3 HISTORICAL CONSUMPTION OF UTILITIES

Historical utility usage data for Fort Gillem was evaluated so savings figures could be compared with actual consumption.

2.3.1 Historical Electrical Energy Consumption

Electrical energy consumption for FY90 and FY91 is tabulated in Table 2-1 on page 2-4. The average monthly electrical consumption varies from a minimum of 1,896,000 kWh in February, to a maximum of 3,048,000 kWh in August. The monthly electrical consumption is illustrated graphically on Figure 2-1 on page 2-5.

TABLE 2-1
ELECTRICAL ENERGY CONSUMPTION
FORT GILLEM

Month	Post-wide Electrical Consumpt. kWh, FY90	Post-wide Electrical Consumpt. kWh, FY91	Post-wide Electrical Consumpt. kWh Avg.90/91
Oct.	2,035,200	2,304,000	2,169,600
Nov.	1,737,600	2,054,400	1,896,000
Dec.	2,131,200	2,102,400	2,116,800
Jan.	2,409,600	2,150,400	2,280,000
Feb.	1,920,000	2,227,200	2,073,600
March	2,121,600	1,958,400	2,040,000
April	1,920,000	2,112,000	2,016,000
May	2,236,800	2,140,800	2,188,800
June	2,707,200	2,649,600	2,678,400
July	2,755,200	2,793,600	2,774,400
Aug.	3,081,600	3,014,400	3,048,000
Sept.	2,515,200	2,544,000	2,529,600
TOTAL	27,571,200	28,051,200	27,811,200

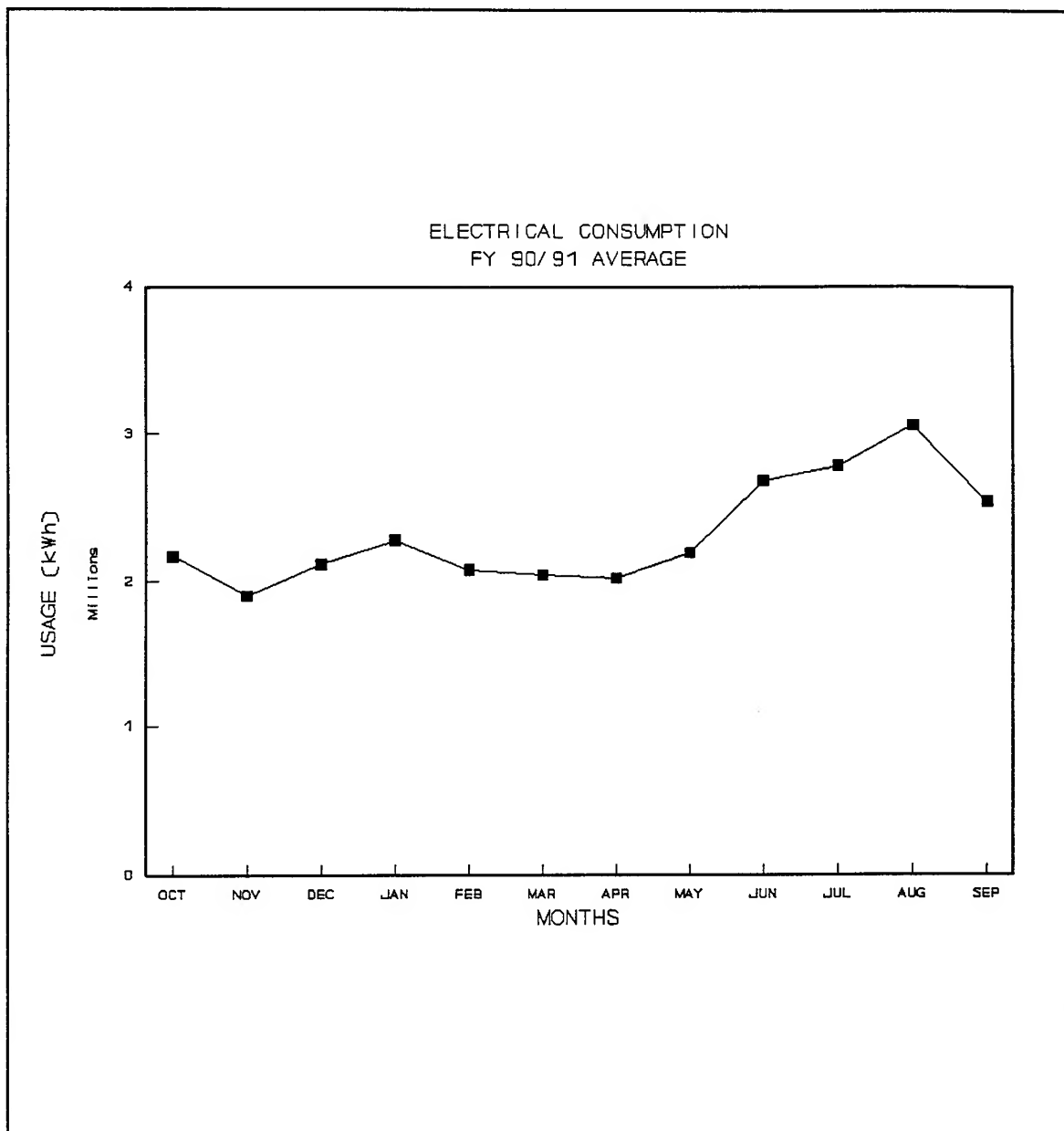


FIGURE 2-1
ELECTRICAL CONSUMPTION

2.3.2 Historical Natural Gas Consumption

Natural gas consumption for FY90 and FY91 is tabulated in Table 2-2 below. The average monthly natural gas consumption varies from a minimum of 12,437 therms in July, to a maximum of 300,308 therms in March. The monthly natural gas consumption is illustrated graphically in Figure 2-2 on page 2-7.

**TABLE 2-2
NATURAL GAS CONSUMPTION
FORT GILLEM**

Month	Post-wide Natural Gas Consumption (Therms - FY90)	Post-wide Natural Gas Consumption (Therms - FY91)	Post-wide Natural Gas Consumption (Therms - Avg.)
Oct.	57,815	54,080	55,948
Nov.	155,197	124,669	139,933
Dec.	365,521	235,094	300,308
Jan.	209,241	299,628	254,435
Feb.	139,875	206,257	173,066
March	113,897	135,811	124,854
April	72,354	36,386	54,370
May	14,396	17,102	15,749
June	12,782	13,485	13,134
July	12,381	12,493	12,437
Aug.	13,431	13,182	13,307
Sept.	13,013	15,507	14,260
TOTAL	1,179,903	1,163,694	1,171,798

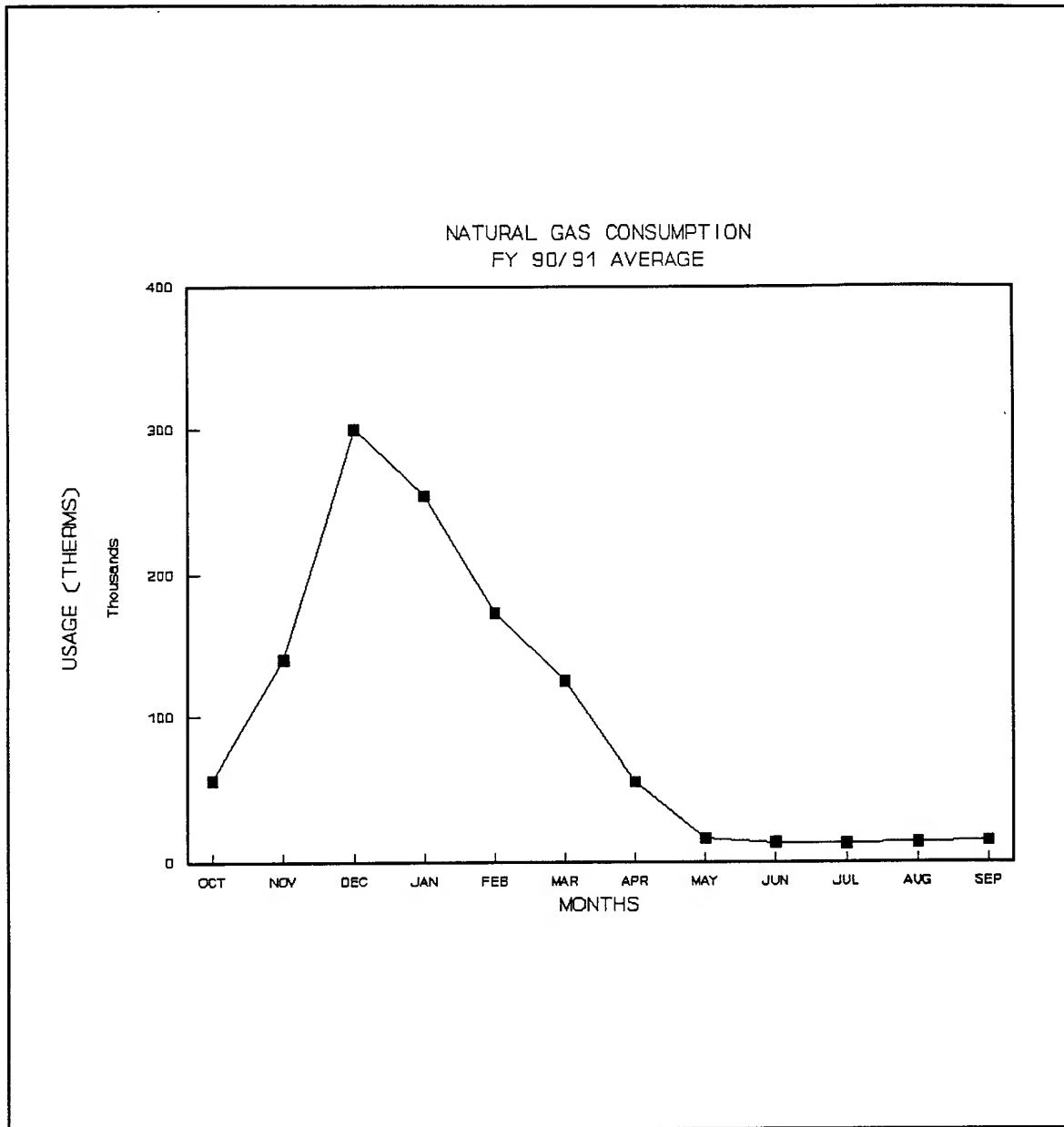


FIGURE 2-2
NATURAL GAS CONSUMPTION

2.4 SUMMARY OF UTILITIES

The percentage comparison of historical consumption and cost for electricity and natural gas are tabulated in Table 2-3 below.

TABLE 2-3
FY91 UTILITY USAGE AND COST COMPARISON

UTILITY	CONSUMPTION FY91		COST FY91	
	(MBtu)	(%)	(\$)	(%)
Electricity	95,739	45	1,470,583	70
Natural Gas	116,369	55	644,169	30
Total	212,108	100	2,114,752	100

2.5 BASIS FOR ECONOMIC ANALYSIS

2.5.1 ECIP Guidance

The ECIP funding program criteria were used to determine project economics. The latest version of "Life Cycle Cost in Design (LCCID)" program, developed by the U.S. Army Construction Engineering Research Laboratory, was used to calculate life cycle cost benefits. The maximum economic life and uniform present worth (UPW) factors for natural gas, electricity, and non-energy items for DOE Region 3, from NISTIR-85 are listed in Table 2-4 on page 2-9.

TABLE 2-4
UNIFORM PRESENT WORTH FACTORS

CATEGORY	MAXIMUM ECONOMIC LIFE	UPW ELEC- TRICITY	UPW NATURAL GAS	UPW NON- ENERGY
Steam and condensate systems (including insulation)	25	15.61	23.77	14.53
HVAC, including controls	15	11.11	14.45	10.59
Weatherization	25	15.61	23.77	14.53
Lighting status	25	15.61	23.77	14.53
Energy recovery systems	25	15.61	23.77	14.53
Electrical energy systems, including motor replacements	25	15.61	23.77	14.53

2.5.2 Basis for Energy Cost Savings Benefits

Unit utility costs were calculated from contract information and historical data, to be used with the energy savings in order to estimate the dollar cost avoidance.

For electricity, the following unit cost was used:

- Average electrical energy charge = \$0.0255 per kWh
- Annual peak electrical demand charge = \$8.85 per kW.

For natural gas, the following unit cost was used:

- Average natural gas energy charge = \$4.67 per MBtu.

For water and sewer, the following unit cost was used:

- Combined water and sewer charge = \$2.91 per thousand gallons.

2.5.3 Basis for Labor and Material Costs

The following sources were used to develop the cost estimates of materials:

- Mean's Cost Data, 1992 Editions
- Actual cost from similar construction projects
- Equipment vendor estimates.

2.6 DEMAND SIDE MANAGEMENT

On January 10, 1992, Georgia Power Company submitted for approval to the state Public Service Commission of Georgia 14 energy efficiency, demand side management programs. The Public Service Commission of Georgia has 300 days to accept or reject the programs or to provide an alternative programs.

The proposed programs will potentially provide Fort Gillem future incentives for demand side management conversions. Of interest to Fort Gillem are those programs in the categories of Commercial and Industrial Areas, Process Systems, and Buildings Systems.

Process systems include:

- Motors
- Custom energy services
- Small energy services
- Energy analysis
- Interruptible service.

Building systems include:

- Lighting
- HVAC
- New construction
- Standby generation.

If the demand side management program is approved by the Public Service Commission of Georgia, various ECOs evaluated in this ESOS could receive incentives. A preliminary statement issued by the Commission on 7 July 1992 did not include a decision on the demand side management program.

SECTION 3.0

EVALUATION OF ENERGY CONSERVATION OPPORTUNITIES

3.1 GENERAL

A total of 17 ECO projects were evaluated in this study. The evaluation of each ECO was performed as if it were the only ECO implemented. Any reduction of total energy savings resulting from the simultaneous implementation of more than one ECO, if any, was not taken into consideration. A summary of the ECOs evaluated is provided in Section 3.5.

3.2 ECOs EVALUATED

The 17 ECO projects identified in the SOW to be evaluated for selected buildings are listed in Table 3-1 on page 3-2.

During the entrance interview conference, ECO 18 was added, which uses a replacement kit to convert exit signs from incandescent lamps to fluorescent lamps. ECO 18 was evaluated for all buildings specified for ECO 15, lighting controls.

After discussions with DEH, it was also agreed to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results are included as ECO 19; economics are based on design, bid, and construction, direct by the Government, rather than by an energy service contractor under a shared energy savings contract.

After the survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which were not technically feasible were eliminated from further evaluation. A complete list of these ECOs, and the reasons they were eliminated are included in Table 3-2 beginning on page 3-3.

In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list. Table 3-3 on page 3-3 lists buildings added to the ECO evaluations.

Table 3-4 beginning on page 3-4 is a building-ECO matrix, indicating which ECOs are:

- Applicable and evaluated projects
- Not applicable and dropped from further evaluation
- Added as an applicable project.

TABLE 3-1
ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

**TABLE 3-2
NONFEASIBLE ECOs**

BLDG. NO.	ECO NO.	REASON ECO NONFEASIBLE
207	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
400	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
401	5	No motors 1 horsepower or larger
401	14	Loading dock seals: No physical contact; doors kept closed; minimal usage
403	5	No motors 1 horsepower or larger
701-710, 198, 922, 923, 942	All ECOs	Buildings scheduled for demolition

**TABLE 3-3
BUILDINGS ADDED**

ECO NO.	BLDG NO.	COMMENTS
8	935	Evaluate low-flow showers and faucets
13	101	Evaluate thermal storage
18	101, 103, 207, 213, 400, 401, 512, 935	Evaluate exit sign retrofits
	935	Evaluate exit sign retrofits

TABLE 3-4
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
101	Administration	A	A	A	A	A	A	A		A		A	A*			A	A		A*	A*
102	Maintenance				A	A				A							A			A*
103	Fire Station				A	A										A	A		A*	A*
133	Officers Club				A	A			A								A			A*
207	Storage	A*	A*	A*	A	A				A					A	A	A		A*	A*
213	CID Building				A	A										A	A		A*	A*
214	Commissary				A	A				A					A		A			A*
308	Storage				A	A											A			A*
400	DOL				A	A									A	A	A		A*	A*
401	Eighty-first Arc.				A	N				A					N	A	A		A*	A*
403	Dining Facility				A	N											A	A		A*
505	Storage				A	A											A	A		A*
506	Storage																A	A		A*
507	Storage																A	A		A*
508	Storage																A	A		A*
509	Storage																A	A		A*
510	Storage																A	A		A*

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

TABLE 3-4
BUILDING-ECO MATRIX

BLDG #	DESCRIPTION	ECO NUMBER																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
511	Storage																A	A		A*
512	Storage {1}	A	A	A	A	A				A				A	A	A	A		A*	A*
513	Storage																A	A		A*
514	Storage																A	A		A*
735	Theater (T)	A	A	A	A	A											A			A*
935	Fitness Center				A	A		A*								A	A		A*	A*

{1} Representative of Buildings 505 through 514

A - Applicable and evaluated project
N - Not applicable and dropped from further analysis
A* - Added as an applicable project

3.3 ANALYSIS METHODOLOGY

The methodology used for the energy savings and economic analyses includes:

- Prepare computer simulation of selected buildings.
- Run a modified computer simulation of selected buildings, with the ECO implemented, to determine the delta energy usage.
- Develop energy savings factors to extrapolate savings for typical buildings to similar buildings.
- Apply extrapolated energy savings factors to similar buildings.
- Estimate utility savings for various ECOs using manual calculations.
- Prepare cost estimate for ECOs.
- Calculate the total savings and costs for each ECO, including non-energy savings or costs.
- Perform an LCCID calculation to determine the project simple payback and SIR.
- Recommend ECO projects which have an overall project SIR greater than 1.0.
- See Appendix C of this Volume I for backup data on all ECOs.
- See Appendix E of Volume II for computer simulations of selected buildings.
- See Appendix F of Volume II for field survey data describing current conditions.

Special items considered in the analysis included:

- Using Atlanta weather data, the TRACE building simulation program was used to develop utility consumption estimates for three selected buildings. Table 3-5 on page 3-7 is a list of the selected buildings simulated and similar buildings for which estimates were extrapolated.
- Where applicable, the following ECOs were simulated on the selected buildings; the energy savings were then extrapolated to similar buildings:
 - ECO 1, Insulation (Wall and Roof)
 - ECO 2, Insulated Windows
 - ECO 3, Weatherstripping and Caulking
 - ECO 6, Economizers
 - ECO 7, Control Hot Water Circulation Pumps
 - ECO 10, Prevent Air Stratification

- ECO 12, Revise or Repair HVAC Controls
 - ECO 13, Thermal Storage
 - ECO 15, Separate Light Switches
 - ECO 17, Boiler Operation Schedule
- The utility savings for the following ECOs were determined using manual calculations:
 - ECO 1, Insulation (Pipe and Duct)
 - ECO 4, Domestic Hot Water Temperatures
 - ECO 5, High Efficiency Electric Motors
 - ECO 8, Low-Flow Shower and Faucet Fixtures
 - ECO 9, Heat Reclaim from Hot Refrigerant Gas
 - ECO 11, Replace Street Lights
 - ECO 14, Radiant Heaters and Loading Dock Seals
 - ECO 16, Investigate Post Demand Usage
 - See Section 2.0 for utility rates and economic analysis descriptions.

3.4 ECO ANALYSIS

The following ECO sections detail the premises, field survey requirements, basis for analysis, energy savings calculations, improvement descriptions, results, and recommendations for each of the 19 ECOs to be evaluated in this study. Section 4.0 provides an economic summary of the ECOs evaluated. The construction cost identified in the ECO evaluations includes design cost (6%) and SIOH (5.5%). These additional costs were included after the Interim Submittal.

**TABLE 3-5
COMPUTER SIMULATION BUILDINGS**

BLDG. NUMBER	BLDG. FUNCTION	BLDG. CONSTRUCTION	BLDG. OCCUPANCY	SIMILAR BLDG. NUMBERS
101	Administration	Brick & Block	0700-1700 Mon. to Fri.	
207	Storage	Block	0700-1600 Mon. to Fri.	207, 214, 400, 401, 512
M358	Administration	Frame	0700-1600 Mon. to Fri.	735

3.4.1 ECO 1 - INSULATION

3.4.1.1 - Insulate Walls and Roofs

Premise:

This ECO involves adding insulation to existing walls and roofs which are inadequately insulated.

Field Survey:

The walls and roofs were surveyed to determine whether they contain adequate insulation. It was difficult to determine what insulation was present in the buildings with framed-in walls. Discussions with DEH revealed, however, recently remodeled buildings can be assumed to have R-11 fiberglass batt insulation in the walls and R-19 insulation in the ceiling space. This assumption was verified, when possible, by examination of construction plans.

Basis for Analysis:

Heat transfer through the walls and roof of a building is related to the resistance of the construction materials to heat flow. By increasing the resistance of the materials, heat transfer is reduced and energy saved. The most effective way to reduce heat transfer is to add insulation, thereby lowering the U-value. As the U-value decreases, the energy consumption will also decrease, thereby increasing the energy savings. The existing building wall and roof insulation can be improved, as follows:

Wall Insulation:

Bldg. 101:

1" isocyanurate and gypsum board can be installed on the interior of the frame wall for an increased R-value of 9.

Bldgs. 207, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514:

2" polystyrene and stucco can be installed on the exterior of the brick wall for an added R-value of 10.

Roof Insulation:

Bldgs. 207, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514:

3-inch isocyanurate can be attached to the interior of the existing roof for an added R-value of 21.6.

Energy Savings Calculations:

First, the buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was created to simulate the typical building, using a UA (U-value x Area) factor improved by additional insulation. These two models were compared as to the difference in UA factor and the corresponding difference in building energy consumption. The ratio of

3.4.1 ECO 1 - INSULATION (Continued)

3.4.1.1 Insulate Walls and Roofs (Continued)

energy savings per unit UA differential was calculated and applied to the rest of the buildings in the group to determine the annual energy savings for each building.

The following equations were used:

Existing UA	= (existing U-value) x (surface area)
Improved UA	= (improved U-value) x (surface area)
Differential UA	= existing UA - improved UA
Electric savings	= (UA differential) x (electric savings factor)
Demand savings	= (UA differential) x (demand savings factor)
Gas savings	= (UA differential) x (gas savings factor)

where:

Existing U-value	= Existing U-value of wall materials
Improved U-value	= Improved U-value (with insulation added)
Surface area	= Net wall or roof surface area from plans
Electric savings/UA ratio	= Calculated electric savings per change in UA for typical building
Demand savings factor	= Calculated demand savings per change in UA for typical building
Gas savings/UA ratio	= Calculated gas savings per change in UA for typical building

Tables 3-6 and 3-7 on pages 3-11 and 3-12 contain the results of analysis of this ECO.

3.4.1 ECO 1 - INSULATION (Continued)

3.4.1.1 Insulate Walls and Roofs (Continued)

Results: Walls

There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

Results: Roofs (Combined results for buildings with an SIR greater than 1.0.)

Annual Natural Gas Savings (MBtu)	34,889
Annual Electrical Energy Savings (kWh)	891,090
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$185,656
Estimated Construction Cost	\$3,538,381
Analysis Period (years)	25
Simple Payback (years)	19
Savings-to-Investment Ratio (SIR)	1.2

Recommendation: Implement.

TABLE 3-6
ECO 1, WALL INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	19	18,111	217	279	1,477	1,921	0	3,398	135,814	0.4	40
207	0	2,920	76	86	430	0	0	430	135,899	0.1	316
505	0	2,249	58	66	330	0	0	330	105,101	0.1	319
506	0	2,249	58	66	330	0	0	330	105,101	0.1	319
507	0	2,249	58	66	330	0	0	330	105,101	0.1	319
508	0	2,249	58	66	330	0	0	330	105,101	0.1	319
509	0	2,249	58	66	330	0	0	330	105,101	0.1	319
510	0	2,249	58	66	330	0	0	330	105,101	0.1	319
511	0	2,249	58	66	330	0	0	330	105,101	0.1	319
512	0	2,249	58	66	330	0	0	330	105,101	0.1	319
513	0	2,249	58	66	330	0	0	330	105,101	0.1	319
514	0	2,249	58	66	330	0	0	330	105,101	0.1	319

TABLE 3-7
ECO 1, ROOF INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
505	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
506	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
507	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
508	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
509	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
510	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
511	00	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
512	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
513	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
514	0	78,255	3,078	3,345	16,370	0	0	16,370	311,888	1.2	19
207	0	78,255	4,109	4,479	21,957	0	0	21,957	419,503	1.2	19
Total	0	891,090	34,889	37,928	185,656	0	0	185,656	3,538,381	1.2	19

3.4.1 ECO 1 - INSULATION

3.4.1.2 - Insulate Pipes and Ducts

Premise:

This ECO involves reducing energy consumption by adequately insulating ducts and pipes.

Field Survey:

Ducts and pipes in the unconditioned spaces (e.g., attics, crawl spaces, and mechanical rooms) of various buildings were surveyed. Ducts and pipes in conditioned spaces were not surveyed because heat transfer between the fluid and the space contributes to the conditioning of a space and is not considered a loss. The lengths and sizes of the ducts and pipes were determined from building drawings and field measurements. Type of fluid, type of insulation, and thickness of insulation were considered. In most cases, pipes and ducts were insulated.

Basis for Analysis:

Uninsulated or poorly insulated ducts and pipes in unconditioned spaces waste energy; adding adequate insulation will reduce losses. For the purpose of this analysis, adequate insulation thickness is defined as the recommended thickness from Corps of Engineers guide specifications and ASHRAE Standard 90.1 - 1989. Table 3-8 on page 3-16 lists the recommended thicknesses for pipes and ducts used in this ECO. These recommended thicknesses were compared with the survey data of existing insulation. Where it was determined pipes and ducts had no insulation or did not meet recommended insulation thickness, an analysis was done to determine the savings and costs involved with adding enough insulation to achieve the recommended thickness.

Energy Savings Calculations:

The energy savings for this ECO were calculated by subtracting the heat loss of ducts and pipes with recommended insulation thickness from the heat loss of pipes and ducts with existing insulation. The energy savings from a reduction in air leakage for ducts with no insulation was also taken into account. The following equations were used:

Pipes

$$\text{Heat loss, Btu/h} = \frac{L(tf - ta)}{Rt}$$

$$Rt, \text{ Total thermal resistance, } \frac{^{\circ}\text{F ft}}{\text{Btu}} = Rc + Rd$$

$$Rc, \text{ Convection resistance, } \frac{^{\circ}\text{F ft}}{\text{Btu}} = \frac{1}{(.18(ts - ta)^{.33}(Pi(d + 2w))}$$

3.4.1.2 Insulate Pipes and Ducts (Continued)

Energy Savings Calculations: (Continued)

$$R_d, \text{Conduction resistance, } \frac{^\circ\text{F ft}}{\text{Btu}} = \frac{\ln(ro/ri)}{2k\pi}$$

$$t_s, \text{surface temperature, } ^\circ\text{F} = t_a + \frac{R_c}{R_c + R_d}(t_f - t_a)$$

where:

$$t_f = \text{Fluid temperature, } ^\circ\text{F}$$

$$t_a = \text{Ambient temperature, } ^\circ\text{F}$$

$$w, \text{inches} = \text{Insulation thickness}$$

$$k, \frac{\text{Btu}}{\text{hr ft } ^\circ\text{F}} = \text{Thermal conductivity of insulation}$$

$$L, \text{feet} = \text{Pipe length}$$

$$d, \text{inches} = \text{Pipe diameter}$$

$$\pi = 3.14$$

$$r_o, \text{inches} = \text{outside radius of pipe and insulation}$$

$$r_i, \text{inches} = \text{inside radius of insulation}$$

Ducts

$$\text{Heat loss (insulation), Btuh} = UA(t_f - t_a)$$

$$U, \frac{\text{Btu}}{\text{h } ^\circ\text{F ft}^2} = \frac{1}{R_i + R_c + R_d}$$

$$R_d, \text{average conduction resistance, } \frac{^\circ\text{F h}}{\text{Btu}} = 0.65$$

$$R_c, \text{average convection resistance, } \frac{^\circ\text{F h}}{\text{Btu}} = \frac{1}{4.87(A)}$$

$$R_i, \text{thermal resistance of insulation, } \frac{^\circ\text{F h}}{\text{Btu}} = \frac{1}{(k/w)}$$

$$\text{Heat loss (leakage-winter), Btuh} = 1.1 \text{ cfm } (t_f - t_a)$$

$$\text{Heat loss (leakage-summer), Btuh} = 4.5 \text{ cfm } (\text{delta enthalpy})$$

$$\text{cfm} = \frac{FA}{100}$$

$$F, \text{leakage ratio cfm/100 ft}^2 = C_L P^{0.65}$$

3.4.1.2 Insulate Pipes and Ducts (Continued)

where:

t_f , °F	= Fluid temperature
t_a , °F	= Ambient temperature
A, square feet	= Duct surface area
k , $\frac{\text{Btu}}{\text{hr ft } ^\circ\text{F}}$	= thermal conductivity of insulation
w, inches	= Insulation thickness
C_L , cfm/100 ft ² @ 1 inch wg	= leakage class
P, inches wg	= static pressure

Tables 3-9 and 3-10 on page 3-17 provide economic summaries for this ECO.

Results: Pipes

There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

Results: Ducts

Annual Natural Gas Savings (MBtu)	38
Annual Electrical Energy Savings (kWh)	4,596
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$295
Estimated Construction Cost	\$2,040
Analysis Period (years)	25
Simple Payback (years)	6.9
Savings-to-Investment Ratio (SIR)	3.0

Recommendation: Implement.

TABLE 3-8
ECO 1.2, DUCT AND PIPE RECOMMENDED THICKNESSES

FLUID	PIPE SIZE (inches)				
	0.25 - 1.00	1.25 - 2.00	2.25 - 3.00	3.25 - 4.00	4.25 - 6.0
CHILLED WATER PIPES					
Fiberglass	0.50	0.75	1.00	1.00	1.00
Rubber	1.00	1.00	1.00	1.00	1.00
Foam	1.50	1.50	1.50	2.00	2.00
HOT WATER PIPES (Also Condensate)					
Fiberglass	1.50	1.50	1.50	1.50	1.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
STEAM PIPES					
Fiberglass	2.00	2.50	2.50	3.00	3.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
DUCTS	All Sizes				
	2" Fiberglass				

TABLE 3-9
ECO 1, PIPE INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	0	0	7	7	34	0	0	34	1,997	0.4	58.6

TABLE 3-10
ECO 1, DUCT INSULATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
735	0	3,770	32	45	246	0	0	246	1,020	5.0	4.2
101	0	826	6	9	49	0	0	49	1,020	1.0	20.8
Total	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9

3.4.2 ECO 2 - INSULATED WINDOWS

Premise:

This ECO involves replacing existing single pane windows with insulated glass (double pane) windows.

Field Survey:

Selected buildings were surveyed to examine the windows and determine whether they were single or double pane windows. Buildings which already have double pane windows were eliminated from the analysis. Many of the historical buildings have single pane windows.

Basis for Analysis:

Heat transfer through a window is a function of its resistance to heat flow (U-value) and solar radiation gains (shading coefficient). Replacing single panes with double panes lowers both the U-value and shading coefficient of a window, resulting in decreased heat flow and solar radiation gains. Energy savings are thus achieved. In historical buildings, replacement windows would have the same appearance as the existing windows.

Energy Savings Calculations:

The buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was then created to simulate double pane windows. The difference in energy consumption between the two models is the energy savings. The energy savings per square foot of window area was calculated and extrapolated to the rest of the buildings in the group, to calculate the annual energy savings for each building. The following equations were used:

$$\begin{array}{lll} \text{Electric savings} & = & (\text{window area}) \times (\text{electric savings per sqft}) \\ \text{Demand savings} & = & (\text{window area}) \times (\text{demand savings per sqft}) \\ \text{Gas savings} & = & (\text{window area}) \times (\text{gas savings per sqft}) \end{array}$$

Table 3-11 on page 3-19 provides an economic summary of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

TABLE 3-11
ECO 2, INSULATED WINDOWS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (MBtu/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
505	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
506	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
507	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
508	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
509	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
510	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
511	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
512	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
513	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
514	0	4,398	201	216	1,049	0	0	1,049	121,955	0.2	116
101	0	3,363	123	134	660	930	0	1,589	183,878	0.2	116
207	0	665	30	33	159	0	0	158	31,125	0.1	197
735	0	(9)	1	1	6	0	0	6	2,751	0.1	455

3.4.3 ECO 3 - WEATHERSTRIPPING AND CAULKING

Premise:

This ECO involves providing weatherstripping and caulking around windows and doors to reduce infiltration.

Field Survey:

Selected buildings were surveyed to examine the weatherstripping and caulking around doors and windows. The condition of the weatherstripping and caulking varied greatly in the buildings; overall, weatherstripping and caulking were in fair condition.

Basis for Analysis:

Outside air infiltration into a building through cracks, openings, and gaps around doors and windows increases building heating and cooling loads. Adequate weatherstripping and caulking around the windows and doors decreases the amount of infiltration into the building, which saves energy.

Energy Savings Calculations:

The buildings were grouped by common building type. A typical building from each group was simulated by computer to create a baseline model. A second model was then created to simulate reduced infiltration achieved by the addition of weatherstripping and caulking. The difference in energy consumption between the two models is the energy savings. The energy savings per cfm of infiltration was calculated and extrapolated to the rest of the buildings in the group to calculate the annual energy savings for each building. The following equations were used:

$$\text{Infiltration Air Flow} = L(A(dT) - B(v^2))^{1/2}$$

$$\text{Delta Infiltration flow} = \text{Existing infiltration air flow} - \text{improved infiltration air flow}$$

$$\text{Annual Electric Savings} = (\text{Infiltration savings}) \times (\text{electric savings per cfm of infiltration})$$

$$\text{Annual Demand Savings} = (\text{Infiltration savings}) \times (\text{demand savings per cfm of infiltration})$$

$$\text{Annual Gas Savings} = (\text{Infiltration savings}) \times (\text{gas savings per cfm of infiltration})$$

Where:

$$L = \text{effective leaking area} = (\text{leakage area}) \times (\text{leakage factor})$$

$$\text{Infiltration air flow, cfm} = \text{Calculated infiltration for doors and windows}$$

3.4.3 ECO 3 - WEATHERSTRIPPING AND CAULKING (Continued)

Energy Savings Calculations: (Continued)

$A, \text{cfm}^2 \text{in}^{-4} \text{f}^{-1}$	= ASHRAE stack coefficient for building
$dT, ^\circ\text{F}$	= Avg. temperature difference between inside and outside
$B, \text{cfm}^2 \text{in}^{-4} \text{f}^2$	= ASHRAE wind coefficient for building
v, mph	= Avg. local wind speed
Leakage area, ft^2	= Area of doors and windows
Leakage factor, in^3/ft^2	= ASHRAE coefficient to account for weatherstripping and caulking
Electric savings per cfm of infiltration savings	= Calculated electric savings per change in infiltration for typical building
Demand savings per cfm of infiltration savings	= Calculated demand savings per change in infiltration for typical building
Gas savings per cfm of infiltration savings	= Calculated gas savings per change in infiltration for typical building

Table 3-12 on page 3-22 provides an economic summary of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendation: Do not implement.

TABLE 3-12
ECO 3, WEATHERSTRIPPING AND CAULKING

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	2	669	19	21	105	208	0	313	21,926	0.2	70
207	0	178	7	8	38	0	0	38	13,756	0.1	360
505	0	307	13	14	66	0	0	66	20,750	0.1	313
506	0	307	13	14	66	0	0	66	20,750	0.1	313
507	0	307	13	14	66	0	0	66	20,750	0.1	313
508	0	307	13	14	66	0	0	66	20,750	0.1	313
509	0	307	13	14	66	0	0	66	20,750	0.1	313
510	0	307	13	14	66	0	0	66	20,750	0.1	313
511	0	307	13	14	66	0	0	66	20,750	0.1	313
512	0	307	13	14	66	0	0	66	20,750	0.1	313
513	0	307	13	14	66	0	0	66	20,750	0.1	313
514	0	307	13	14	66	0	0	66	20,750	0.1	313
735	0	10	0	0	2	3	0	5	1,474	0.1	310

3.4.4 ECO 4 - DOMESTIC HOT WATER TEMPERATURE

Premise:

The purpose of this ECO is to measure the temperature of the domestic hot water (DHW) in selected buildings.

Field Survey:

A field survey was performed to measure the DHW temperatures at various faucet locations in the building. These temperatures ranged from a low of 92°F in Building 400 to a high of 156°F in Building 403. Table 3-13 beginning on page 3-24 lists the measured DHW temperatures. To minimize energy consumption, set the water heater thermostat at the lowest temperature at which hot water will meet the occupants' needs.

TABLE 3-13
ECO 4, DOMESTIC HOT WATER TEMPERATURE MEASUREMENTS

Bldg. No.	Bldg. Descript.	Hot Wtr Temp.	Bldg. No.	Bldg. Descript.	Hot Wtr Temp.	Bldg. No.	Bldg. Descript.	Hot Wtr Temp.
101	Admin.	150	214	Commissary	139	505	Storage	144
101	Admin.	141	214	Commissary	130	505	Storage	151
102	Maint.	128	214	Commissary	146	512	Storage	101
102	Maint.	138	308	Storage	140	512	Storage	129
103	Fire Stn	133	400	DOL	131	513	Storage	144
103	Fire Stn	134	400	DOL	96	513	Storage	151
133	Club	155	400	DOL	92	735	Theater	155
133	Club	152	400	DOL	110	735	Theater	155
207	Storage	142	401	81st	108	935	Fitness	129
207	Storage	142	403	Dining	120			
207	Storage	125	403	Dining	136			
213	CID Bldg	122	403	Dining	156			

3.4.5 ECO 5 - INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

Premise:

This ECO involves replacing existing standard efficiency motors with new high-efficiency motors to save electrical energy in selected buildings.

Field Survey:

Nameplate data was collected on existing motors and the power consumption of motors above 10 hp was measured (see Appendix E). Motors having measured FLA 25% less or 10% more than the nameplate FLA were noted. This condition could indicate the motors are undersized or oversized, respectively, for the application. Most motors were NEMA Design B, with standard efficiency ratings.

Basis for Analysis:

Motor efficiency is the ratio of the energy output of the motor to energy input. The lower the efficiency, the more energy will be expended for a given output. By replacing standard efficiency motors with premium efficiency motors, electrical energy will be saved.

Energy Savings Calculations:

Energy savings was calculated by subtracting the electrical demand of a premium efficiency motor from that of the existing motor and multiplying that difference by the annual hours of operation. The following equations were used:

$$\text{Electrical demand (kW)} = (\text{hp} \times 0.746 \times \text{LF}) \times (1/\text{motor eff.})$$

$$\text{Electrical energy savings (kWh/yr)} = ((\text{kW of existing motor}) - (\text{kW of high efficiency motor})) \times (\text{hrs of operation per yr})$$

where:

hp	= Motor nameplate horsepower
0.746	= kW per horsepower
LF	= Motor load factor
Motor eff.	= Efficiency of motor

Nameplate information was used for existing motors. If nameplate information was not available on existing motors, data for a NEMA Design B, 1750 rpm, standard motor was used. The savings available due to premium efficiency motors was corrected for motor load. For motors controlled by variable frequency drives, the motor load was reduced to account for annual load factor reduction due to variable volume HVAC equipment. The efficiency of the variable frequency drive would remain the same for either type of motor, and does not change the predicted savings.

3.4.5 ECO 5 - INSTALL HIGH EFFICIENCY ELECTRIC MOTORS (Continued)

Table 3-14 on page 3-27 provides an economic summary of this ECO.

Results:

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	71,225
Annual Demand Savings (kW)	11
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$2,918
Estimated Construction Cost	\$37,154
Analysis Period (years)	25
Simple Payback (years)	12.7
Savings-to-Investment Ratio (SIR)	1.2

Recommendation: Implement.

If electric motors are being replaced due to failure, the DEH should consider replacing standard efficiency motors with premium efficiency motors. The differential cost of a premium efficiency motor versus a standard efficiency motor will pay back over a short period due to the utility savings. A table of system economics for various motor sizes and operating hours is provided in Appendix C with ECO 5 backup calculations.

TABLE 3-14
ECO 5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	4	25,493	0	87	650	455	0	1,106	10,132	1.7	9.2
214	1	10,031	0	34	256	141	0	397	5,601	1.1	14.1
213	14	26,425	0	90	674	397	0	1,071	16,122	1.0	15.1
207	1	5,364	0	18	137	63	0	200	3,041	1.0	15.2
103	0	3,912	0	13	100	46	0	146	2,259	1.0	15.5
TOTAL	11	71,225	0	243	1,816	1,102	0	2,918	37,154	1.2	12.7
512	0	2,461	0	8	63	29	0	92	1,447	0.9	16.1
133	0	3,206	0	11	82	38	0	119	2,025	0.9	17.0
400	1	6,557	0	22	167	146	0	313	5,704	0.87	18.2
308	0	4,070	0	14	104	48	0	151	2,770	0.8	18.3
102	0	1,585	0	5	40	19	0	59	1,153	0.8	19.6
935	1	4,171	0	14	106	72	0	178	3,578	0.8	20.1
735	0	727	0	2	19	34	0	53	1,324	0.6	25.2

3.4.6 ECO 6 - ECONOMIZERS

Premise:

This ECO involves using outside air economizers on air handling units (AHUs) to optimize the use of "free" outside air for cooling, to maintain comfort conditions within the space, whenever possible.

Field Survey:

AHUs were surveyed to determine outside, return, and relief air dampers and controls, including measurements or estimates of minimum ventilation rates on selected buildings.

Basis for Analysis:

Economizers consist of controlling return air, outside air, and relief air dampers to provide "free" outside air for cooling, whenever possible. The economizer controls set the dampers to provide 100% outside air when outside air temperatures are capable of satisfying the cooling load. As outside air temperatures drop, the dampers are modulated to provide the required mixed air temperature. When outside air temperatures are above the temperature required to satisfy the cooling load, outside air is modulated to the minimum required for ventilation. The actual demand for cooling is considered in optimizing of damper controls.

The amount of energy which can be saved is limited by:

- The six month operating schedule of the cooling systems.
- Outside air temperatures during the cooling season, which are rarely cool enough to satisfy the inside cooling load.
- Operation of the economizers throughout the heating season, which will also improve occupant comfort during the heating season, when buildings often overheat, but can increase heating loads. (This analysis assumes economizer operation only during the cooling season.)

Installation of an economizer requires installation of linked return air and outside air dampers and operators, with specialized dry bulb economizer controls. In some cases, one or more of these dampers may already exist. Additional duct work may be required to bring in outside air and expel relief air. The dry bulb economizer control must be interfaced into the existing control system.

Energy Savings Calculations:

The baseline condition was simulated by computer for typical buildings, using either measured or design ventilation rates. When no information was available on ventilation rates, a standard minimum ventilation rate of 20 cfm per person was used. This ECO was evaluated using the dry bulb economizer control strategy, as described above.

3.4.6 ECO 6 - ECONOMIZERS (Continued)

Energy Savings Calculations: (Continued)

Energy Savings Calculations: (Continued)

Economizer energy savings for the typical buildings were extrapolated to obtain savings for similar buildings, based on the following assumptions:

- An economizer should carry the same fraction of the cooling load for similar buildings.
- Similar buildings have the same cooling load per square foot of floor area.

Table 3-15 on page 3-30 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-15
ECO 6, ECONOMIZERS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	0	37,833	0	129	965	0	0	965	39,924	0.4	41.4

3.4.7 ECO 7 - CONTROL HOT WATER CIRCULATION PUMP

Premise:

This ECO involves controlling the hot water and DHW circulation pumps to minimize pump operation.

Field Survey:

Nameplate data were recorded and operating sequences were determined for the hot water and DHW circulation pumps in selected buildings. The DHW pumps run continuously all year round, but the hot water pumps run continuously during the heating season and are turned off at other times.

Basis for Analysis:

Circulation pumps are used to pump conditioned water to various areas in a building. Many times during the heating season these pumps are not used, such as during unoccupied periods with night setback, or when heating loads are met by other means. During these times, they can be turned off, thereby saving energy. For the purpose of this analysis, the pump was cycled on and off according to heating demand. Space temperature setpoints were lowered during unoccupied periods (night setback mode).

Optimization controls would be installed to shut off the circulation pumps during unoccupied periods and when heating loads are met in the building. These controls would optimize the operation of the pumps by using a building occupancy schedule and space temperature sensors to determine if there is a need for heating. An outside air temperature sensor would also be included, to determine the optimum start and stop times.

Energy Savings Calculations:

Electrical energy savings are the difference between the existing energy consumption (pump running continuously) and the improved energy consumption (pump cycled to meet heating demand). Boiler electrical consumption is included.

Heating energy savings will be achieved because the controls installed to cycle the pump will also be able to implement a night setback of the space temperature setpoints. These savings are the difference between the existing energy consumption (constant space temperature setpoint) and improved energy consumption (setpoint lowered during occupied periods). The following equations were used:

Pump Electric Usage	= (electric load) x (hours of operation)
Electric Savings	= existing electric usage - improved electric usage
Gas Savings	= existing gas usage - improved gas usage

Table 3-16 on page 3-33 provides an economic summary of this ECO.

3.4.7 ECO 7 - CONTROL HOT WATER CIRCULATION PUMP (Continued)

Results:

Annual Natural Gas Savings (MBtu)	233
Annual Electrical Energy Savings (kWh)	124,564
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$4,264
Estimated Construction Cost	\$11,003
Analysis Period (years)	15
Simple Payback (years)	2.6
Savings-to-Investment Ratio (SIR)	4.6

Recommendation: Implement.

TABLE 3-16
ECO 7, CONTROL HOT WATER CIRCULATION PUMP

Bldg:	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6

3.4.8 ECO 8 - INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

Premise:

This ECO involves replacing shower heads and faucets with low-flow shower heads and faucets to minimize hot water consumption.

Field Survey:

Shower and faucet flow rates on selected buildings were measured. Low-flow shower heads and faucets were then installed and the flow rates remeasured. Flow rates as high as 5.6 were measured.

Basis for Analysis:

Standard shower heads and faucets use more hot water than necessary. The heating of this extra water increases building energy and water consumption.

Energy Savings Calculations:

The energy savings was found by calculating the energy needed to heat the water for existing shower heads and faucets, and subtracting the energy required for low-flow shower heads and faucets. Water savings were calculated in the same manner.

$$\begin{aligned}\text{Existing Annual Usage} &= (\text{no. of people}) \times (\text{gpm}_p) \times (\text{usage time}) \\ \text{Low-Flow Annual Usage} &= (\text{no. of people}) \times (\text{gpm}_l) \times (\text{usage time}) \\ \text{Annual Energy Savings} &= (\text{present gal per yr} - \text{low-flow gal per yr}) \times \\ &\quad (8.33) \text{ Cp} \times (\text{shower water temperature} - \\ &\quad \text{supply water temperature})/\text{eff}\end{aligned}$$

where:

$$\begin{aligned}\text{No. of people} &= \text{Occupants in building} \\ \text{gpm}_p &= \text{Present gallons per minute} \\ \text{gpm}_l &= \text{Low-flow gallons per minute} \\ \text{Usage time} &= \text{Minutes of usage per year} \\ 8.33 &= \text{lbs per gallon} \\ \text{Cp} &= \text{Specific heat of water, 1 Btu per lb } ^\circ\text{F} \\ \text{eff} &= \text{Efficiency of water heater; gas-70\%, electric-100\%} \\ \text{shower water} & \\ \text{temperature} &= 102^\circ\text{F} \\ \text{supply water} & \\ \text{temperature} &= 66^\circ\text{F}\end{aligned}$$

Table 3-17 on page 3-36 provides an economic summary of this ECO.

3.4.8 ECO 8 - INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

(Continued)

Results:

Annual Natural Gas Savings (MBtu)	99
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$550
Total Annual Cost Savings	\$1,010
Estimated Construction Cost	\$925
Analysis Period (years)	15
Simple Payback (years)	0.9
Savings-to-Investment Ratio (SIR)	13.5

Recommendation: Implement.

TABLE 3-17
ECO 8, INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
935	0	0	99	99	460	0	550	1,010	925	13.5	0.9

3.4.9 ECO 9 - HEAT RECLAIM FROM HOT REFRIGERANT GAS

Premise:

This ECO involves reclaiming heat from hot refrigerant gas and using it for heating domestic hot water (DHW).

Field Survey:

Data from vapor compression cooling machines and DHW loads on selected buildings was collected.

Basis for Analysis:

Heat can be reclaimed from hot refrigerant gas via a refrigerant desuperheater which transfers heat from hot refrigerant gas to circulating water. The desuperheater would be installed in the hot gas piping between the compressor and condenser, where it precools the hot gas entering the condenser. Heat transfer is limited by the temperature of the hot gas, which does not normally exceed 160°F. The maximum practical water temperature which can be generated is about 140°F, ideal for DHW heating. Desuperheaters reclaim about 2,600 Btuh of heat per ton of refrigeration load in heating water from 75°F to 140°F.

The following factors influence the performance of the desuperheater:

- Refrigeration systems which operate year round will produce more hot water than refrigeration systems operating seasonally. Food refrigeration systems are ideal candidates, while space cooling systems are poor candidates.
- DHW loads must be substantial to justify the cost of installing a desuperheater. Office buildings are poor candidates, while food service facilities are good candidates.

Food service facilities typically have walk-in coolers with substantial refrigeration loads, and also have significant DHW loads. Buildings 133 (Fort Gillem) and 500 (Fort McPherson) are food service facilities; however, Building 500 was selected for analysis because it has a greater DHW load.

The hot refrigerant gas heat reclaim system consists of refrigerant desuperheaters on each refrigeration system, a DHW tank, a small pump, and insulated water piping. The 200-gallon storage tank is sized to store hot water generated at night when there is no consumption of hot water.

3.4.9 ECO 9 - HEAT RECLAIM FROM HOT REFRIGERANT GAS (Continued)

Energy Savings Calculations:

Building 500 is equipped with two 7.5 ton refrigeration systems serving two walk-in coolers. Assuming a 50% load factor, a desuperheater will heat 867 gallons of water per day from 75°F to 140°F. At an estimated 250 meals per day, the daily DHW usage is 600 gallons, with a DHW heating load of 286,000 Btu per day. The desuperheaters are thus capable of supplying the entire DHW load. Assuming a 75% efficiency for the existing gas water heater, the resulting annual energy savings is 139 MBtu. The desuperheater will require a small, 60-watt pump for water circulation, adding 526 kWh to the current annual electricity usage.

Table 3-18 on page 3-39 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: The best case evaluation of Building 500 indicates poor economics. Do not implement.

TABLE 3-18
ECO 9, HEAT RECLAIM FROM HOT REFRIGERANT GAS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
500	0	0	158	158	738	0	0	738	16,579	0.6	22.5

3.4.10 ECO 10 - PREVENT AIR STRATIFICATION

Premise:

This ECO involves providing ceiling fans to lower warm air stratified in high bay ceilings to floor level, to be used for space heating.

Field Survey:

Measurements of air temperatures near the floor and near the ceiling were taken in Building 512 (Fort Gillem) to determine stratification. Temperatures at floor level were measured at 65°F, while temperatures near the ceiling were about 68°F.

Basis for Analysis:

The temperature stratification in a conditioned space depends upon:

- Air changes between the upper and lower portions of the space.
- Amount of insulation in the ceiling.

For the purposes of this study, the air changes between the upper and lower portions of the space were estimated at 8.4 air changes per hour (ACH), which is caused by:

- Natural convection.
- Unit heaters in the upper portion which blow air downward.

Installing ceiling fans to increase air changes between upper and lower portions will decrease stratification, thereby lowering the temperature in the upper portion, reducing heat losses through the roof, and saving energy.

Two options for ceiling fans were evaluated:

- Blade-type industrial ceiling fans delivering about 40,000 cfm with a power consumption of 145 watts.
- Four-way fans providing a choice of destratification, exhaust, or ventilation in a single unit. Four-way fans will deliver about 40,000 cfm with a power consumption of 7,300 watts.

Blade-type ceiling fans were selected over four-way fans for further analysis, because of the lower power consumption and lower cost.

One ceiling fan is required for each 5,000 square feet of floor area. Up to 15 ceiling fans may be controlled by a manual 10 amp, 220 volt switch. Installed cost of ceiling fans are estimated at \$135 per 1000 square feet of floor area, including electrical service.

3.4.10 ECO 10 - PREVENT AIR STRATIFICATION (Continued)

Energy Savings Calculations:

Energy savings from ceiling fans were based on computer simulation of Building 336. The baseline condition was determined by simulation the building on the computer with the upper and lower portions of the space divided into two zones; the upper zone maintained at 68°F and the lower zone at 65°F.

Ceiling fans are typically sized for about 25 ACH, which would reduce stratification to about one-third of existing levels. Air temperatures in the upper portion of the space would be reduced from the current 68°F to 66°F while the lower portion would remain at 65°F. A second model was then created by lowering the upper zone temperature from 68°F to 66°F. Annual energy savings is the difference in energy consumption between the two models. Additional electricity consumption by the ceiling fans was calculated.

Table 3-19 on page 3-42 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-19
ECO 10, PREVENT AIR STRATIFICATION

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
207	0	(63,948)	511	293	749	0	0	749	32,357	0.5	43.2
102	0	(8,566)	68	39	100	0	0	100	4,334	0.5	43.2
214	0	(71,495)	571	327	838	0	0	838	36,175	0.5	43.2
400	0	(32,819)	262	150	385	0	0	385	16,669	0.5	43.2
401	0	(4,283)	34	20	50	0	0	50	2,167	0.5	43.2
512	0	(51,538)	412	236	604	0	0	604	26,078	0.5	43.2
TOTAL	0	(232,650)	1,869	1,065	2,726	0	0	2,726	117,717	0.5	43.2

3.4.11 ECO 11 - REPLACE STREET LIGHTS

Premise:

This ECO involves reducing lighting levels from street lights and replacing street light bulbs with higher efficiency bulbs where applicable.

Field Survey:

A visual inspection of the street lights was performed before daylight to determine relative lighting levels. The type of lamp in each fixture was noted. During the field survey, no excessively lit areas were observed. Existing lighting levels are in the 0.1 to 1.5 footcandle range. Recommended street lighting levels are 0.5 to 2.0 footcandle range. Fort Gillem is presently operating on minimal street lighting; therefore, light reduction is not recommended. However, some existing bulbs could be replaced with higher efficiency high-pressure sodium (HPS) or metal halide bulbs.

Basis for Analysis:

Replacing low-efficiency mercury vapor and quartz bulbs with higher efficiency HPS bulbs can save energy. The list below indicates the proposed bulb replacements:

<u>Now in use</u>	<u>Lumens per bulb**</u>	<u>Proposed change*</u>	<u>Lumens per bulb**</u>
175 Watt Mercury Vapor	8,000	150 Watt HPS	13,000
400 Watt Mercury Vapor	20,000	360 Watt HPS	35,000
1500 Watt Quartz Lamp	35,800	400 Watt HPS	45,000
500 Watt Quartz Lamp	20,000	200 Watt HPS	19,800

Replacing quartz bulbs with higher efficiency HPS bulbs will also have non-energy labor savings, because quartz bulbs have a shorter life than HPS bulbs.

* Source: The Energy Saver's Guide to Good Outdoor Lighting, published by the National Lighting Bureau.

** Approximate vertical lumens reflect initial light output (Sylvania Large Lamp Catalog).

3.4.11 ECO 11 - REPLACE STREET LIGHTS (Continued)

Energy Saving Calculations:

The savings realized from replacing low-efficiency bulbs with higher efficiency bulbs is calculated by:

$$\begin{aligned}\text{Electrical Demand (kW)} &= (\text{present bulb wattage-replacement bulb wattage}) \times \\ &\quad (\text{number of bulbs})/1000 \\ \text{Energy Reduction (kWh)} &= (\text{Electrical Demand} \times \text{hours "ON" per year}) \\ \text{Hours "ON" per year} &= 3,285 \text{ hours}\end{aligned}$$

Table 3-20 on page 3-45 contains results of the analysis of this ECO.

Results: (Combined results for lighting with SIR greater than 1.0)

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	4,928
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$174
Total Annual Cost Savings	\$300
Estimated Construction Cost	\$2,682
Analysis Period (years)	25
Simple Payback (years)	8.9
Savings-to-Investment Ratio (SIR)	1.7

Recommendation: Implement.

TABLE 3-20
ECO 11, REPLACE STREET LIGHTS

Exist. Bulb	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
1500W Quartz	0	0	0	0	0	0	0	0	0	0	0
500W Quartz	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
400W M.Vapor	0	263	0	1	7	0	0	7	176	0.6	26.2
175W M.Vapor	0	10,019	0	34	256	0	0	256	9,114	0.4	35.5

3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS

Premise:

The ECO proposes to repair or modify existing HVAC controls or to install new HVAC controls in selected buildings. Only one building, Building 101, was selected for this ECO.

Field Survey:

A field survey was performed to gather information about existing operating conditions, equipment, and controls in Building 101.

Basis for Analysis:

HVAC systems with improperly operating controls are inefficient. These systems often operate when not needed, or over-condition spaces, thereby wasting energy.

Building 101:

This administration building houses areas with extensive computer and communication equipment. The HVAC system comprises a combination of AHUs and fan coil units (FCUs). The building is primarily occupied on weekdays, but some areas are occupied continuously. For FCUs in areas occupied primarily on weekdays, the proposed control strategy is to provide direct digital control to shut off the FCUs at night and during unoccupied periods. For AHUs in the computer area, the proposed control strategy is only to monitor and alarm space temperatures.

The proposed control strategy for AHUs on the 4th floor is to provide direct digital control of heat and cooling coils and shut off fans to perform night setback; also, associated pumps, chillers, and boilers would be turned off during unoccupied periods; and to reset chilled water and hot water supply temperatures.

Energy Savings Calculations:

Building 101 was computer simulated to create a baseline model. This model was then modified to simulate the proposed control modifications to the building. These two models were then compared, to calculate the change in building energy consumption. The amount of this change was then used to calculate the annual energy cost savings. Six hours per year labor savings (non-energy) were estimated for a reduction in temperature-related (too hot, too cold) work orders.

Table 3-21 on page 3-48 provides an economic summary of this ECO.

3.4.12 ECO 12 - REVISE OR REPAIR HVAC CONTROLS (Continued)

Results:

Annual Natural Gas Savings (MBtu)	302
Annual Electrical Energy Savings (kWh)	285,187
Annual Demand Savings (kW)	57
Annual Non-Energy Cost Savings	\$127
Total Annual Cost Savings	\$14,661
Estimated Construction Cost	\$57,547
Analysis Period (years)	15
Simple Payback (years)	3.9
Savings-to-Investment Ratio (SIR)	2.9

Recommendation: Implement.

TABLE 3-21
ECO 12, REVISE OR REPAIR HVAC CONTROLS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9

3.4.13 ECO 13 - THERMAL STORAGE

Premise:

This ECO evaluates using thermal storage systems for reducing electric demand. Chillers could produce ice at night to be used for space cooling during daytime peak electric demand hours. Chillers could, therefore, be turned off during peak electric demand hours, thus reducing demand charges.

Field Survey:

The field survey included collection of all necessary data to evaluate the ECO.

Basis for Analysis:

Based on historical electrical demand data, peak post demand occurs between the hours of 1200 hours and 1600 hours on weekdays. Computer simulations of typical office buildings at the fort indicate 30% of the afternoon peak electric demand can be attributed to space cooling equipment. Since demand charges throughout the year are based on the summertime peak electrical demand, reducing actual peak summer electrical demand will reduce electrical demand costs year round.

It is proposed to install a modular ice bank thermal storage system with a dedicated chiller. The system would supplement the existing chiller. Ice would be generated between 1800 and 0600 hours to be used for cooling between 1200 and 1600 hours. The existing chiller would be used to generate chilled water during the remaining hours of the day.

Utility Savings Calculations:

Using a building simulation computer program, a baseline model for energy consumption was established for each building. A second model was created, incorporating the thermal storage system. The annual energy savings is the difference in energy consumption between the two models.

Thermal storage does not save energy; rather, it shifts electrical demand to night time, thus leveling electrical demand and reducing electrical demand charges. Energy usage is slightly increased due to additional chiller power consumption in generating chilled brine at 25°F rather than chilled water at 42°F.

Table 3-22 on page 3-50 contains the results of analysis of this ECO.

Results: There were no buildings with an SIR greater than 1.0.

Recommendations: Do not implement.

TABLE 3-22
ECO 13, THERMAL STORAGE

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non- Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
101	126	(39,069)	0	(133)	(996)	12,935	0	11,939	349,748	0.4	29.3

3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS

3.4.14.1 ECO 14 - Radiant Heaters

Premise:

This ECO involves installing radiant heaters, in place of steam or gas unit heaters, for heating of warehouses. The new heaters could save energy over the present heaters. The radiant heaters investigated are the indirect, gas-fired, tube-type, which are ceiling mounted.

Field Survey:

Data relating to heating equipment and heating load, including insulation and infiltration were collected in selected buildings.

Basis for Analysis:

Most of the energy savings from radiant heating is from reduction in indoor air temperatures. Radiant heaters provide heat to people by direct radiation from the heaters and by reradiation from the floor. At maximum operating conditions, people may feel an operative temperature of 70°F in a room with a 50°F air temperature. Less heat is lost from the building at the lower room air temperatures than would be the case with conventional heating systems, which must provide warmer room air temperatures to maintain the same comfort level. High infiltration rates in warehouses also favor radiant heating. Additional energy savings are the result of better combustion efficiency and elimination of air circulation fans.

The radiant heaters on which this analysis is based are modular 150,000 Btuh units, installed in a pattern near the ceiling. Gas piping is routed to each modular unit, along with electrical service for the draft fans. Flue gasses may be routed to common headers to minimize new roof penetrations. Each modular unit is controlled by a separate thermostat, which allows variation of operative temperature throughout the building.

Energy Savings Calculations:

Indirect, gas-fired, infrared radiant heaters were analyzed based on "Development of Radiant Heating Economic Evaluation Methods," prepared for the Department of the Army (USAREUR) under Contract No. DACA90-88-D-0022, Delivery Order 0008.

Table 3-23 on page 3-53 provides an economic summary of this ECO.

3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS
(Continued)

3.4.14.1 ECO 14 - Radiant Heaters (Continued)

Results:

Annual Natural Gas Savings (MBtu)	12,860
Annual Electrical Energy Savings (kWh)	1,687,945
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$103,097
Estimated Construction Cost	\$1,064,948
Analysis Period (years)	15
Simple Payback (years)	10.3
Savings-to-Investment Ratio (SIR)	1.3

Recommendations: Do not implement.

TABLE 3-23
ECO 14, RADIANT HEATERS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
207	0	155,626	1,329	1,860	10,175	0	0	10,175	97,930	1.4	9.6
214	0	173,993	1,486	2,080	11,376	0	0	11,376	109,488	1.4	9.6
400	0	79,870	682	955	5,222	0	0	5,222	50,259	1.4	9.6
401	0	28,618	244	342	1,871	0	0	1,871	18,009	1.4	9.6
505	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
506	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
507	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
508	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
509	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
510	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
511	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
512	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
513	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
514	0	125,425	1,071	1,499	8,200	0	0	8,200	78,926	1.4	9.6
Total	0	1,692,360	14,452	20,228	110,647	0	0	110,647	1,064,948	1.4	9.6

3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS (Continued)

3.4.14.2 Loading Dock Seals

Premise:

This ECO involves installing loading dock seals on warehouse buildings to reduce infiltration.

Field Survey:

The field survey included observation of loading dock doors and the collection of data to determine the annual space heating energy usage.

Basis for Analysis:

To unload, trucks currently back up to loading docks with overhead doors. The crack between truck and door was observed to be about six inches around the perimeter of the door. This large crack contributes significantly to infiltration. The loading dock seals eliminate infiltration through the crack.

Loading dock seals consist of flexible hypalon side and head curtains, which automatically seal the crack between the truck and the door when the truck is at the dock.

Energy Savings Calculations:

Detailed analysis was performed on Building 207 and results were extrapolated to other buildings.

Infiltration rates were calculated based on the ASHRAE crack method, which uses the estimated crack area, average weather conditions, building height, and wind shielding factors. For warehouses, the cracks between trucks and doors, assuming five open doors, cause about 0.5 air changes per hour (ACH) for the building, due to the doors alone.

Computer simulation was used to establish the baseline energy consumption for Building 207. Infiltration was assumed to be 1.0 ACH. The baseline model was then modified by lowering the infiltration rate to 0.5 ACH and the building resimulated. Annual energy savings is the difference in energy consumption between the baseline and modified simulations.

Table 3-24 on page 3-56 provides an economic summary of this ECO.

3.4.14 ECO 14 - RADIANT HEATERS AND LOADING DOCK SEALS
(Continued)

3.4.14.2 ECO 14 - Loading Dock Seals (Continued)

Results:

Annual Natural Gas Savings (MBtu)	4,234
Annual Electrical Energy Savings (kWh)	110,603
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$22,729
Estimated Construction Cost	\$113,516
Analysis Period (years)	15
Simple Payback (years)	5.0
Savings-to-Investment Ratio (SIR)	2.8

Recommendations: Implement.

TABLE 3-24
ECO 14, LOADING DOCK SEALS

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
214	0	5,267	202	220	1,082	0	0	1,082	5,406	2.8	5.0
505	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
506	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
507	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
508	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
509	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
510	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
511	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
513	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
514	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
512	0	10,534	403	439	2,165	0	0	2,165	10,811	2.8	5.0
Total	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0

3.4.15 ECO 15 - SEPARATE LIGHT SWITCHES

Premise:

This ECO involves adding switches, either manual or occupancy sensor type, to reduce the operating hours of lighting.

Field Survey Notes

The field survey team observed and noted the following conditions in each building.

Room Number - if the number was not clearly marked on the plans or near the actual room, EMC assigned a number for that room, depending on its location, and a CAD sketch of the building, including room numbers, was provided.

Number of Fixtures- total number of fixtures per room.

Fixture Type - brief description of lighting fixture type (i.e., fluorescent, incandescent, metal halide).

Watts per Fixture - estimated wattage per fixture.

On or Off During Survey - whether the light was on or off during the survey.

Switch Yes or No - whether the lighting has local switch(es).

Number of Switches - number of light switches.

Unoccupied, Lights "ON" - whether the lights were turned on in an unoccupied room.

Good for Occupancy Sensor - whether the physical configuration of the light switch and room makes it a good candidate for an occupancy sensor type light switch.

Basis for Analysis:

Currently, interior lighting is left on, either because no local switching is available (only circuit breakers) or because people do not turn the lights off when they leave their offices for short periods of time. Providing light switches can save energy. For the purposes of this study, two types of lighting controls were reviewed for improving light controls:

- Occupancy sensor type light switches
- Manual light switches

3.4.15 ECO 15 - SEPARATE LIGHT SWITCHES (Continued)

Basis for Analysis: (Continued)

Occupancy sensor type light switches can provide the greatest potential savings, by automatically shutting lights off in areas which are unoccupied. The configuration of the room, the location of the existing light switch, and the number of fixtures in the room determine the type of occupancy sensor which should be installed. The savings calculations were based on 19% of the lights, which would have otherwise been left on during normal occupied hours, being turned off by the occupancy sensor light switches.

For the purposes of this study, it was assumed a small office with less than four light fixtures could have occupancy sensors installed directly in place of the existing light switch. For a larger, open area, with four or more fixtures, an overhead occupancy sensor with relay controls would be required. In large, open areas with modular furniture panel systems, which currently have no switching, manual light switches would be provided for every six light fixtures. This approximates the design standards in Department of Energy Standard 10 CFR Part 435.

Savings calculations for large open areas assume lights are left on unnecessarily one extra hour per day, five days per week, because there are no lighting switches other than circuit breakers.

Energy Savings Calculations

A combination of spreadsheet and computer simulations was used to estimate the power and energy savings for lighting and air-conditioning, and the additional costs for heating. The lighting savings were determined room-by-room using spreadsheets. Air-conditioning and heating savings and costs due to a reduction in lighting, were determined by computer simulation. The typical building baseline model was made, then a second model was made to simulate the reduction in lighting loads. The difference of electrical and gas energy consumptions is the electrical savings and gas costs, respectively. The results for typical buildings were extrapolated for similar buildings.

In areas where occupancy sensor controls are proposed, the following utility savings calculation method was used:

Percent Unoccupied Lights "ON" (A) = 19% - average of all buildings surveyed

Hours "ON" per Year (B) = The annual hours lights are "ON" is based on building occupancy schedule

3.4.15 ECO 15 - SEPARATE LIGHT SWITCHES (Continued)

Energy Savings Calculations (Continued)

Lighting kW Saved (C) = The total lighting demand (kW) x (A)

Lighting kWh Saved per Year (D) = (B) x (C)

Total Gas Increase (MBtu) = (D) x (natural gas increase energy factor)

Total kWh Saved per Year = (D) x (electric saving energy factor)

Table 3-25 beginning on page 3-60 contains the results of analysis of this ECO.

Results:

Annual Natural Gas Savings (MBtu)	(18)
Annual Electrical Energy Savings (kWh)	47,766
Annual Demand Savings (kW)	11
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$2,277
Estimated Construction Cost	\$30,072
Analysis Period (years)	25
Simple Payback (years)	13.2
Savings-to-Investment Ratio (SIR)	1.1

Recommendations: Implement.

TABLE 3-25
ECO 15, SEPARATE LIGHT SWITCHES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
103	0	1,702	(1)	5	41	31	0	72	436	2.4	6.1
213	2	9,316	(2)	30	230	236	0	466	3,349	2.1	7.2
935	1	6,193	(12)	32	131	126	0	257	3,465	1.1	13.5
101	7	30,555	(10)	81	735	747	0	1,482	22,822	1.0	15.4
Total	11	47,766	(18)	145	1,136	1,141		2,277	30,072	1.1	13.2
400	1	1,723	(3)	3	30	54	0	85	2,417	0.5	28.6
207	3	15,020	(29)	23	250	325	0	575	15,815	0.4	30.6
505	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6
506	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6
507	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6
508	0	19,718	(8)	59	465	33	0	498	26,891	0.3	58.6

TABLE 3-25 (Continued)
ECO 15, SEPARATE LIGHT SWITCHES

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
509	0	19,718	(8)	59	465	33	0	498	29,154	0.3	58.6
510	0	19,718	(8)	59	465	33	0	498	29,154	0.3	58.6
511	0	19,718	(8)	59	465	33	0	498	29,154	0.3	58.6
512	0	19,718	(8)	59	465	33	0	498	29,154	0.3	58.6
513	0	19,718	(8)	59	465	33	0	498	29,154	0.3	58.6
514	0	19,718	(8)	59	465	33	0	498	29,154	0.3	58.6
401	0	951	(2)	2	17	0	0	17	2,208	0.1	131.6

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE

Premise:

Electrical billing demand at Fort Gillem accounted for a major portion of the total electrical charges in FY91. Fort Gillem should evaluate how billing demand could be reduced through load shedding and other load shifting applications.

Basis for Analysis:

Table 3-26 on page 3-67 lists the monthly billing demand and actual demand for FY91. Figure 3-1 on page 3-68 graphically depicts the 30-minute electrical demand interval readings for a typical winter week. Figure 3-2 on page 3-69 depicts a typical summer week. The demand readings were provided by Georgia Power account representatives. The FY91 actual demand for Fort Gillem ranged from a high of 6,864 kW in August 1991 to a low of 4,800 kW in November 1990.

The billing demand is calculated from the greatest of the following three criteria:

- Current monthly actual demand
- 95% of the highest demand during the previous June through September
- 60% of the highest demand during the previous October through May.

The billing demand during June, July, August, and September 1991, was based on the actual demand, because of high temperature and humidity periods resulting in heavy air-conditioning loads. The billing demand for October 1990 through May 1991 was based on 95% of the highest demand in the previous summer months, a system which is referred to as "demand ratchet." The billing demand was never based on the highest demand set in October through May. See Section 2.2.1 for further evaluation and explanation of the electrical rate structure.

The analysis of billing demand, and a review of the 30-minute demand readings, suggest Fort Gillem should reduce demand by various available methods during summer weekdays, from 1200 to 1600 hours. This action will reduce billing demand (95% of the highest demand during the previous June through September).

To accomplish these reductions, Fort Gillem should consider the following load reducing strategies:

- Load shedding
- Thermal storage systems
- Absorption or gas driven chiller systems
- Lighting control systems
- Power generation
- High efficiency electrical equipment.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Load Shedding:

A computer-based Utility Control System (UCS) can control various electrical loads to better manage post demand. The UCS would monitor instantaneous post demand and calculate that demand at one-minute intervals. If the UCS predicted the electrical demand was to exceed a peak value limit (target), it would shed or cycle selected loads on a prescheduled priority basis, to reduce the connected load before the actual peak exceeds the target. The UCS could be programmed to provide, for example, eight load priority levels. In the load shed software, the lowest priority level would be shed before the load in the next higher priority level. Loads shed within a priority level would be rotated automatically, to avoid any load from always being shed first. All loads shed in the highest priority levels would be restored before loads in lower priority levels.

The UCS could incorporate one or both of the following basic system types:

- Hardwired UCS with dedicated fiber optic data transmission system
- One-way FM radio transmission UCS.

The hardwired UCS would utilize microprocessor-based remote control units (RCUs) mounted in each building or in groups of buildings located in close proximity. The electrical loads would be wired to an RCU. A central operator station at the DEH would allow for monitoring of the post demand and programming of the RCU with the required load shed parameters. A fiber optic data transmission system would be used to communicate between the RCUs mounted at buildings, the RCU mounted at the electrical substation, and the central operator station. Because of two-way communications, the equipment monitoring, temperatures, status, and other conditions could be monitored at buildings using this type of system. A typical application of this type of system is the control of building HVAC fans, chillers, pumps, and other major electrical loads.

A one-way FM radio transmission UCS would utilize a micro-processor based digital control unit (DCU) FM radio-controlled switch, designed to switch remote loads on and off in response to commands from a central operator station. The control signals for this UCS are transmitted via FM radio signals. DCUs can be field programmed with 256 individual addresses. This type of system does not have two-way communications and would not provide equipment status monitoring. However, it has the advantage of being less expensive when controlling numerous, small electrical loads which are remotely located throughout the post. A typical application of the DCU system is in controlling small air-conditioning direct expansion (DX) compressors and electric water heaters, such as that used for family housing units.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Load Shedding: (Continued)

The family housing units at Fort Gillem were surveyed and it was determined there are a total of 5 heat pump DX compressor units, with a total of 47 kW load which could be load shed on a rotating basis.

Other electrical loads which could be shed include electric water heaters, swimming pool pumps, electric clothes dryers, and electric golf cart chargers.

Thermal Storage System:

Thermal storage systems can reduce electrical demand by generating a mass of cold liquid or ice during off peak electrical periods, then using this mass to meet cooling requirements during peak electrical periods.

The primary advantage of a thermal storage system is the ability to use lower time-of-day electricity rates and off-peak demand rates to produce cold liquid or ice, which can be used instead of chillers to provide cooling for HVAC equipment during peak electrical use. Fort Gillem does not have a "time-of-day" type of rate structure which can make thermal storage extremely attractive, but if the overall peak electrical demand can be reduced by shutting off chillers during peak summer periods, demand charges can be reduced for the whole year, due to demand charge ratchets.

Thermal storage systems are most effective when used with major air cooled or water cooled chiller systems. See ECO 13, Section 3.4.13, for an evaluation of thermal storage systems for Fort Gillem.

Absorption or Gas Driven Chiller Systems:

Absorption or gas driven chiller systems can reduce electrical demand by generating chilled water for HVAC equipment using steam, hot water, or direct fired chiller equipment, all the time, or only during peak electrical periods. This approach would reduce the electrical demand used for cooling, and may be attractive, since Atlanta Gas Light has special rate structures for summer air-conditioning natural gas usage.

Absorption or gas driven chiller systems are most effective where major air or water cooled chiller systems are in operation.

Lighting Control Systems:

Automatic lighting controls can reduce electrical energy and electrical demand (see ECO 15, Section 3.4.15.1). An occupancy sensor type of control will automatically switch lighting based on the presence or absence of people in a room. When a person enters a room, the sensor automatically switches the lights on. The lights remain on as long as someone is in the room. When the room is unoccupied, the sensor automatically turns the lights off, after a few minutes of delay.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Lighting Control Systems: (Continued)

The best applications for occupancy sensor light switches include:

- Private offices
- Restrooms
- Hallways
- Lounges
- Computer rooms
- Clerical areas
- Conference rooms
- Classrooms
- Warehouse aisles
- Storage rooms
- Copier rooms
- Loading docks

Power Generation:

Peak shaving, standby, and emergency generators can be utilized to generate part of the electrical demand during peak periods, thereby reducing the demand charges. The cost for generating electrical energy using this type of equipment is normally quite high, compared to purchasing the energy from Georgia Power directly; however, the reduction in demand charges for operating the generators for a minimum number of hours during peak summer months can offset the cost to operate the generator.

A number of standby and emergency generators at Fort Gillem are candidates for this purpose, if the organization using this power source agrees to substitute generator power.

Fort Gillem may also wish to consider installing a peak shaving generator, designed either to handle a specific set of loads (e.g., chillers, motors) in one building, or connected to the facility power grid. This would be most applicable to buildings with large electrical loads, such as major chiller equipment.

High Efficiency Electrical Equipment:

Utilizing high efficiency electrical equipment in place of standard or lower efficiency sources would reduce electrical demand if this equipment operates during the peak electrical demand periods. ECOs evaluated for this study describe the possible alternatives, including:

- ECO 19, Lighting replacements
- ECO 5, High efficiency motors
- ECO 18, Exit sign replacements.

These ECOs are generally applicable to most buildings and most systems at Fort Gillem.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

Miscellaneous Systems:

Utilizing gas appliances in place of electric appliances can reduce electric demand charges, if those items are utilized during a period when the post demand is peaking. An example would be to replace existing clothes dryers with gas clothes dryers. During the field survey of personnel quarters, it was noted electric clothes dryers are provided throughout. Natural gas was available in most buildings, and could be used for replacement clothes dryers.

Demand Side Management:

Georgia Power has submitted a plan to the State Public Utility Commission to provide "demand side management" incentives to owners for various conversions and systems operations which would reduce peak demand. This plan would provide the Government with financial incentives for all the items proposed, except for the absorption chiller system. See Section 2.5 for further discussions on the Georgia Power demand side management program.

Sample Calculation for Reducing Peak Demand:

Table 3-27 on page 3-70 contains a sample cost per kW saved of the various alternatives presented for reducing post demand. Of the sample alternatives evaluated, occupancy sensor lighting control has the lowest construction cost per kW saved in this example.

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

TABLE 3-26
FY91 HISTORICAL ELECTRICAL DEMAND - FORT GILLEM

MONTH	BILLING DEMAND (kW)	ACTUAL DEMAND (kW)
Oct.	5,875	6,348
Nov.	4,800	6,348
Dec.	5,136	6,348
Jan.	5,443	6,348
Feb.	5,290	6,348
March	5,280	6,348
April	5,347	6,348
May	6,240	6,348
June	6,576	6,576
July	6,816	6,816
Aug.	6,864	6,864
Sept.	6,768	6,768

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

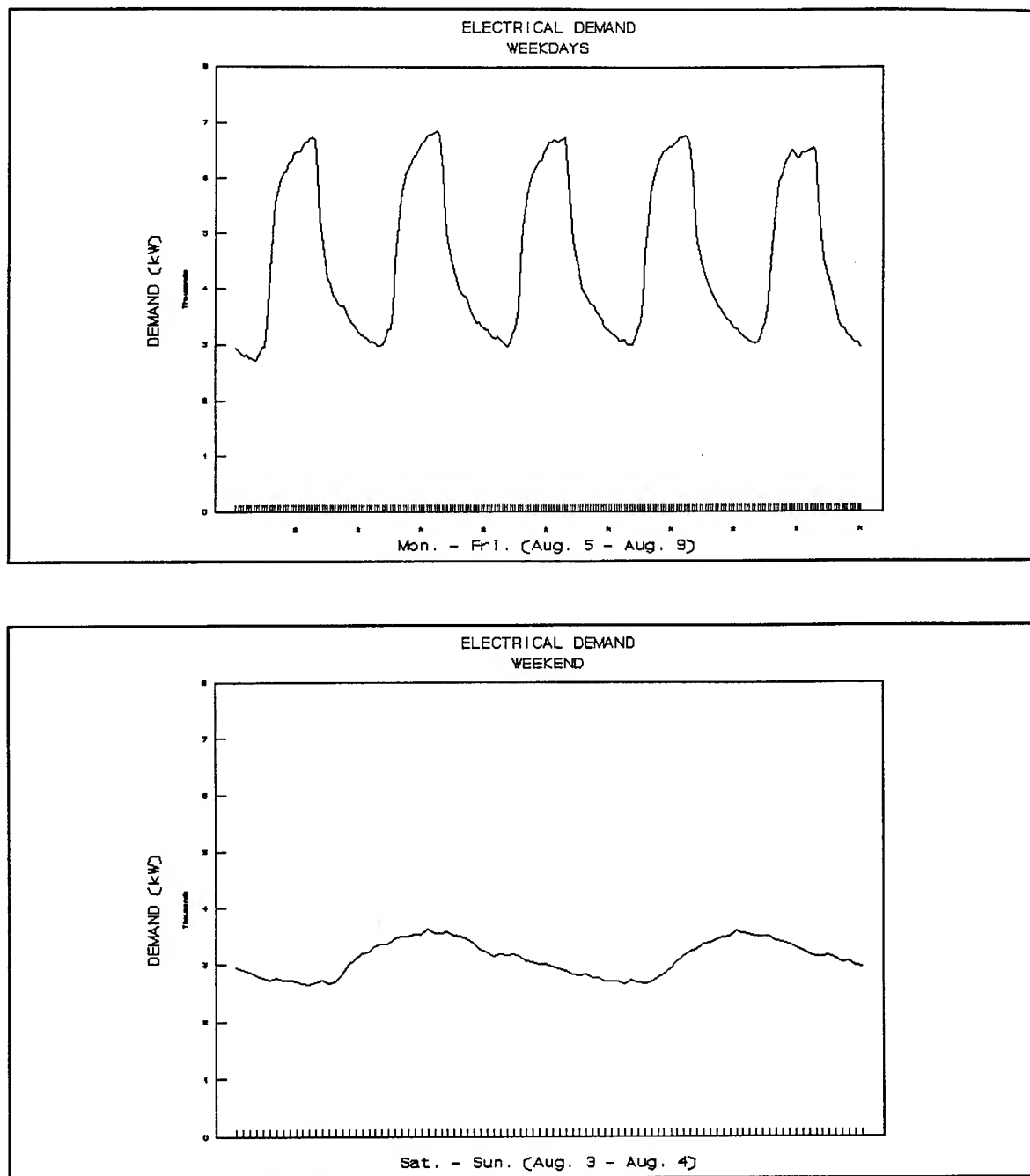


FIGURE 3-1
FY91 TYPICAL HOURLY DEMAND - FORT GILLEM
SUMMER

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

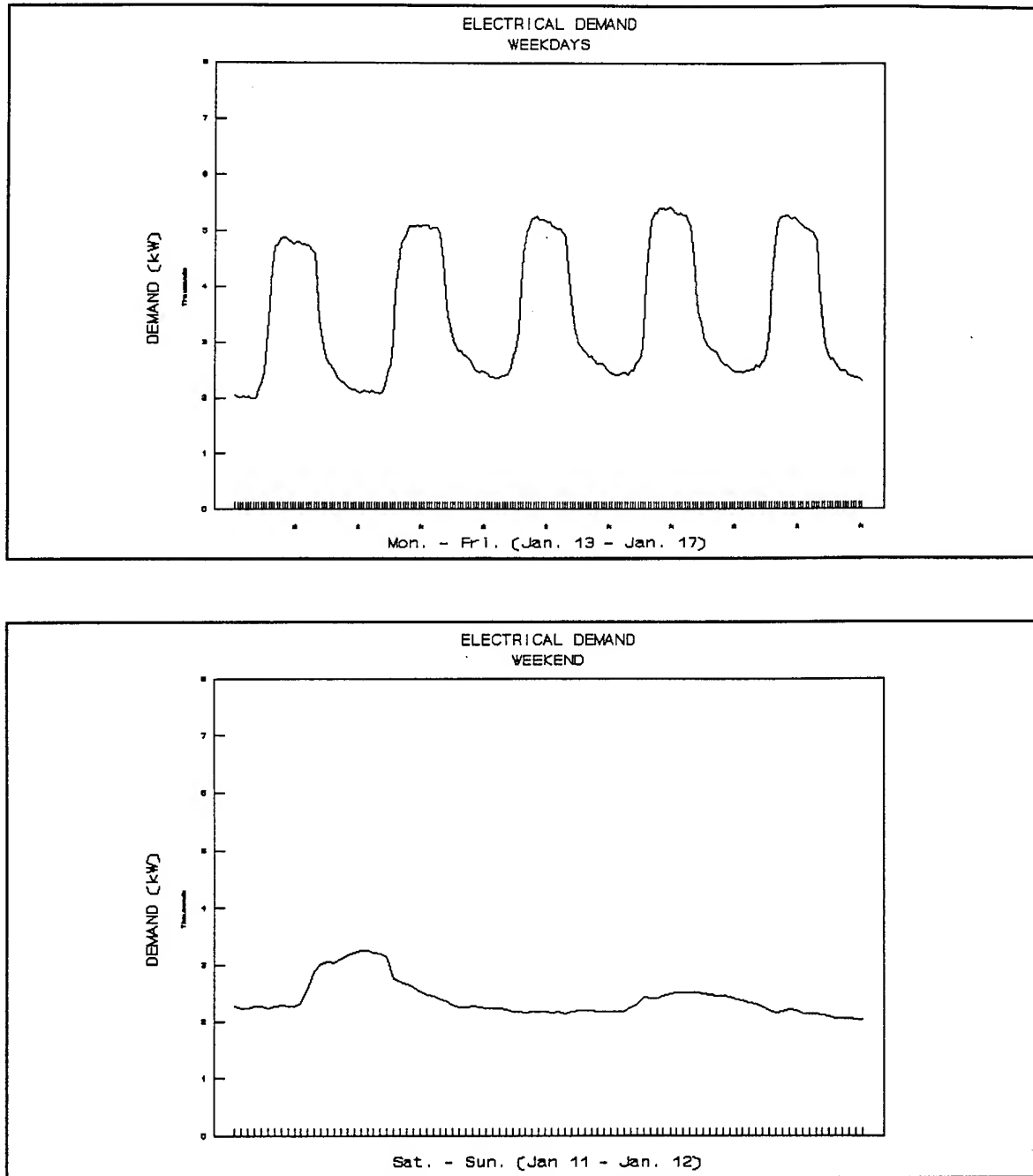


FIGURE 3-2
FY91 TYPICAL HOURLY DEMAND - FORT GILLEM
WINTER

3.4.16 ECO 16 - INVESTIGATE POST DEMAND USAGE (Continued)

TABLE 3-27
DEMAND SAVINGS COMPARISON

ALTERNATIVE FOR REDUCING PEAK DEMAND	CONSTRUCTION COST (\$ PER kW SAVED)
1. One-way FM radio transmission UCS, with 108 switches, 175 kW load	420
2. Ice storage system, 750 tons, 487 kW load	1,553
3. Natural gas engine driven chiller, 460 tons, 300 kW load reduction	1,334
4. Office occupancy lighting control, 0.31 kW lights	210
5. Diesel engine generator set, 500 kW	260
6. High efficiency electric motor, 5 hp, .81 kW saved	602
7. Exit sign fluorescent lamp replacement kit, 10 kits, 0.3 kW saved	1,267

3.4.17 ECO 17 - BOILER OPERATION SCHEDULE

Premise:

This ECO evaluates continuous, 24-hours-per-day operation of the boiler versus the current operation at 16 hours per day.

Field Survey:

Data was collected to determine the annual energy usage of the building.

Basis for Analysis:

Boilers in warehouses at Fort Gillem are currently shut off from 8 p.m. to 4 a.m. to conserve energy. The effectiveness of this energy conservation practice has been questioned. When the boiler is turned off, the building cools off slowly, moderated by the thermal mass of the building, which releases heat to the conditioned space. The thermal mass of the buildings is sufficient to maintain the conditioned space above freezing temperatures for the eight hours the boiler is off.

At 4 a.m., the boiler is turned back on and must satisfy the heating load of the building, in addition to reheating the thermal mass of the building. The concern is whether the amount of energy required to reheat the thermal mass exceeds the energy savings of turning off the boilers.

No equipment modifications are necessary for this ECO.

Energy Savings Calculations:

Energy savings calculations were performed on Building 207. The baseline condition (16 hour boiler operation) was simulated by computer, accounting for the thermal mass of the floor, walls, and ceiling of the building. A second model was created to simulate continuous 24 hour operation of the boilers. Annual energy savings is the difference in energy consumption between the two models.

The result of the analysis for Building 207 was a 2,588 MBtu annual savings in natural gas consumption, if the boilers were shut off between 2000 and 0400 hours, and a \$12,164 savings in annual energy cost. These results were extrapolated to Buildings 505 through 514 by a ratio of UA values. Total savings is indicated in the results on the following page.

3.4.17 ECO 17 - BOILER OPERATION SCHEDULE (Continued)

Results:

Annual Natural Gas Savings (MBtu)	21,878
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$
Total Annual Cost Savings	\$102,166
Estimated Construction Cost	\$0
Analysis Period (years)	N/A
Simple Payback (years)	N/A
Savings-to-Investment Ratio (SIR)	N/A

Recommendations: Not Applicable.

3.4.18 ECO 18 - REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

Premise:

This ECO involves replacing incandescent lamp exit signs with fluorescent bulb kits.

Field Survey:

Exit signs were counted and typical wattage ratings obtained.

Basis for Analysis:

It is assumed the existing exit signs are equipped with two 20 watt incandescent lamps, with an estimated lamp life of 10,000 hours. These bulbs could be replaced with a 9 watt fluorescent lamp pack, also having an estimated lamp life of 10,000 hours. No labor savings was accounted for. There would be a higher recurring cost to replace bulbs because the fluorescent lamps cost more than the existing lamps.

To accomplish the replacement, The existing exit signs must be grounded, metal framed, with incandescent bulbs. Minimum interior sign dimensions must be met.

Energy Saving Calculations:

kW Savings per fixture	= (Change in Watts)/1000
kWh Savings per fixture per year	= (Change in Watts) x (8760 hours per yr)/1000
Increased Recurring Cost per year (\$)	= ((\$7.95) - (2*\$2.25))*(8760 hr/10,000 hr)
	= \$3.02/yr
Where: Change in Watts	= Wattage of existing exit sign - Wattage of retrofit kit

Table 3-28 beginning on page 3-74 contains the results of analysis of this ECO.

Savings per fixture:

kW Savings per year	= (40W-9W) x (12 months)/1000 = 0.372 kW/yr
kWh Savings per year	= (40W-9W) x (8760 hours/yr)/1000 = 271.56 kWh/yr

Results: (Combined results for buildings with SIR greater than 1.0)

Annual Natural Gas Savings (MMBtu):	0
Annual Electrical Energy Savings (kWh/yr):	142,700
Annual Demand Savings (kW/yr):	16
Annual Non-Energy Cost Savings:	(\$1,640)
Total Annual Cost Savings:	\$3,686
Estimated Construction Cost:	\$23,007
Analysis Period:	25
Simple Payback:	6.2
Savings-to-Investment Ratio (SIR):	2.5

Recommendation: Implement.

TABLE 3-28
ECO 18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
G101	2	18,396	0	63	471	216	(211)	475	2,966	2.5	6.2
103	0	2,365	0	8	61	28	(27)	61	381	2.5	6.2
207	1	12,614	0	43	323	148	(145)	326	2,034	2.5	6.2
213	1	10,512	0	36	269	123	(121)	271	1,695	2.52.5	6.2
G400	1	12,614	0	43	323	148	(145)	326	2,034	2.5	6.2
G401	1	5,256	0	18	135	62	(62)	136	8847	2.5	6.2
505	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
506	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
507	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
508	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
509	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
510	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2

TABLE 3-28 (Continued)
ECO 18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KIT

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
511	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
512	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
513	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
514	1	7,884	0	27	202	92	(91)	204	1,271	2.5	6.2
935	0	2,102	0	7	54	25	(24)	54	339	2.5	6.2
Total	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2

3.4.19 ECO 19 - PREVIOUS LIGHTING STUDY REVIEW

Premise:

This ECO involves the review and updating of studies prepared by both Pacific Northwest Laboratory and Stone & Webster Engineering Corporation for shared energy savings (SES) lighting retrofit projects. The feasibility of a Government-funded lighting project is also evaluated.

Basis for Analysis:

Feasibility Analysis for a Shared Energy Savings Lighting Retrofit in Building 200 at Ft. McPherson, by Pacific Northwest Laboratory, January 1991.

This report determined the applicability and cost-effectiveness of an SES lighting project at Fort McPherson (Buildings 200, 246, 122, 184, 65, 358, and 170). The project proposed to retrofit the existing fluorescent fixtures with: 1) optical reflectors; 2) optical reflectors and cathode-cutout ballasts; 3) optical reflectors and electronic ballasts; or 4) to replace the existing fixtures entirely with new fixtures incorporating glare reducing parabolic louvers and cathode-cutout ballasts. The report recommended against the SES lighting retrofit project because the resulting light reduction would bring lighting levels below the minimum acceptable standards in the majority of the facilities. Based on this conclusion, this project was determined not to be feasible for Government funding.

Feasibility Study for Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem, Georgia, by Stone & Webster Engineering Corporation, July 1990.

This report considered the viability of an SES lighting project at Fort McPherson, Building 200 and offices, and Fort Gillem, warehouses and offices. In the office areas, the existing fixtures were recommended for replacement with new, more efficient fluorescent fixtures having approximately the same or higher illuminance levels. In the warehouse areas, the existing fluorescent system was recommended for replacement with a new, more efficient, HPS system which would deliver the same or higher illuminance levels.

Table 3-28 on page 3-78 contains the results of analysis of this ECO.

Energy Savings Calculations:

In the Pacific Northwest Laboratory report, the project was determined not to be technically feasible; therefore, no further analysis was performed on the report results.

3.4.19 ECO 19 - PREVIOUS LIGHTING STUDY REVIEW (Continued)

Energy Savings Calculations: (Continued)

Further analysis was performed on the project proposed in the Stone & Webster report. Construction costs were escalated using the Military Construction Program (MCP) to yield new energy savings at current rates.

Results:

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	2,971,800
Annual Demand Savings (kW)	1,270
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$206,159
Estimated Construction Cost	\$2,380,795
Analysis Period (years)	25
Simple Payback (years)	11.5
Savings-to-Investment Ratio (SIR)	1.3

Recommendation: Implement.

TABLE 3-29
ECO 19, PREVIOUS LIGHTING STUDY REVIEW

Bldg.	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
Office	483	1,130,220	0	3,854	28,821	49,585	0	78,405	854,115	1.4	1.09
Whse.	787	1,841,580	0	6,280	46,960	80,793	0	127,754	1,526,690	1.2	12.0
Total	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

3.5 ECO PROJECT SUMMARY

Table 3-30 on page 3-80 lists each ECO evaluated in the Interim Submittal, along with the ECO number designation. Table 3-31, beginning on page 3-81, lists all the ECOs evaluated, listed by ECO number. The table provides the predicted annual energy savings (type and amount), annual dollar savings, construction costs (including SIOH and design costs), and life cycle economics, including SIR and simple payback.

Table 3-32, beginning on page 3-82, provides the same list of ECO results, listed in order of descending SIR.

To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than \$300,000, an SIR greater than 1.0, and a simple payback less than 8 years. Projects which normally do not meet ECIP criteria, but have an overall SIR greater than 1.0, are referenced as non-ECIP projects.

TABLE 3-30
ENERGY CONSERVATION OPPORTUNITIES LIST

ECO NUMBER	ECO DESCRIPTION
1	Insulate Walls, Roofs, Pipes, and Ducts
2	Insulate Windows
3	Weatherstripping and Caulking
4	Domestic Hot Water Temperature
5	Install High Efficiency Electric Motors
6	Economizers
7	Control Hot Water Circulation Pump
8	Install Low-flow Shower and Faucet Fixtures
9	Heat Reclaim from Hot Refrigerant Gas
10	Prevent Air Stratification
11	Replace Street Lights
12	Revise or Repair HVAC Controls
13	Thermal Storage
14	Radiant Heaters and Loading Dock Seals
15	Separate Light Switches
16	Investigate Post Demand Usage
17	Boiler Operation Schedule
18	Replace Exit Sign Bulbs with Fluorescent Bulb Kit
19	Previous Lighting Review Study

TABLE 3-31
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
1-Pipe Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking		NO BUILDINGS WITH SIR GREATER THAN 1.0									
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
8-Shower/Faucet	0	0	99	99	460	0	550	1,010	925	13.5	0.9
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3

TABLE 3-31
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER
(CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
16-Demand		NOT APPLICABLE									
17-Boiler		NOT APPLICABLE									
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

TABLE 3-32
ECONOMIC SUMMARY OF ECOS, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	99	99	460	0	550	1,010	925	13.5	0.9
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
TOTAL	1,365	5,638,109	24,935	44,166	260,367	140,145	(789)	399,223	4,455,080	1.4	11.1
4-HW Temp		NOT APPLICABLE									
1-Pipe Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									

TABLE 3-32
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR
(CONCLUDED)

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
9-Heat Reclaim					NO BUILDINGS WITH SIR GREATER THAN 1.0						
6-Economizer					NO BUILDINGS WITH SIR GREATER THAN 1.0						
17-Boiler											
16-Demand											
10-Air Stratification					NO BUILDINGS WITH SIR GREATER THAN 1.0						
13-Thermal Storage					NO BUILDINGS WITH SIR GREATER THAN 1.0						

3.6 RESULTS

Of the individual ECOs evaluated, 12 projects had an SIR greater than 1.0 (see Table 3-32 on page 3-83). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total savings and costs associated with these 12 projects are:

• Annual Electrical Savings (kWh):	5,638,109
• Annual Electrical Demand Savings (kW):	1,365
• Annual Natural Gas Savings (MBtu):	24,935
• Total Energy Savings (MBtu):	44,166
• Total First Year Annual Utility Cost Avoidance (\$):	399,223
• Total Construction Cost (\$):	4,455,080

All ECOs which were determined to have SIRs less than 1.0 should be dropped from further analysis. These include:

- - ECO 1, Pipe Insulation
- ECO 1, Wall Insulation
- ECO 2, Insulated Windows
- ECO 3, Weatherstripping and Caulking
- ECO 6, Economizers
- ECO 9, Heat Reclaim from Hot Refrigerant Gas
- ECO 10, Prevent Air Stratification
- ECO 13, Thermal Storage

SECTION 4.0

ENERGY CONSERVATION PROJECTS

4.1 PROJECT DEVELOPMENT

The individual ECOs determined to be economically viable were reviewed at the Interim Submittal review conference with the Fort Gillem DEH and the Savannah District COE, and grouped into projects for possible funding under three main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Subsequent to the Interim Submittal, the Fort McPherson DEH provided a list of buildings which have reimbursed utilities (NAF buildings) at Fort Gillem. These facilities were eliminated from the possible ECIP funded projects. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal to be revised to take into account lower individual ECO construction cost estimates.

To qualify as an ECIP project, an ECO, or several combined ECOs, must have a construction cost estimate greater than \$300,000, a savings-to-investment ratio (SIR) greater than 1.0, and a simple payback less than 8 years. The overall project, and each discrete part of the project, must have an SIR greater than 1.0. At Fort Gillem, no projects were evaluated for ECIP funding because the construction cost of all combined economically feasible projects was less than \$300,000.

Non-ECIP projects, funded under the QRIP program, must have a construction cost estimate less than \$100,000 and a simple payback period of 2 years or less. Projects funded with MCA funds must have a construction cost greater than \$200,000 and a simple payback period of 4 to 25 years. At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1, including the following ECOs:
 - ECO 1, Add duct insulation
 - ECO 1, Add roof insulation
 - ECO 5, Install high efficiency electric motors
 - ECO 7, Control hot water circulation pumps
 - ECO 11, Replace street lights
 - ECO 12, Revise or repair HVAC controls
 - ECO 14, Infrared heaters
 - ECO 15, Separate (automatic) light switches
 - ECO 18, Replace exit signs bulbs with fluorescent bulb kits.
- MCA Project 2, previous lighting review study, for light fixture replacement.

ECO 8, which involves installing low flow shower and faucet fixtures, was evaluated as a low-cost or no-cost ECO to be performed by in-house maintenance staff.

ECOs evaluated for NAF facilities which have an SIR greater 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

The results of analysis for each project are contained in the following sections. The backup calculations for these projects are provided in Appendix D to this Volume I. See Section 3.0 for details related to the evaluation of individual ECOs.

Any reduction of total energy savings resulting from the simultaneous implementation of more than one ECO, if any, was not taken into consideration. It is estimated the reduction in savings is negligible.

4.2 ECIP PROJECTS

No projects qualified for funding under the ECIP program.

4.3 NON-ECIP PROJECTS

4.3.1 QRIP Project

No projects qualified for funding under the QRIP program.

4.3.2 MCA Project-1

This project involves installing a combination of several ECOs on buildings and mechanical equipment to reduce utility costs. The ECOs include:

- ECO 1, Add duct insulation
- ECO 1, Add roof insulation
- ECO 5, Install high efficiency electric motors
- ECO 7, Control hot water circulation pumps
- ECO 11, Replace street lights
- ECO 12, Revise or repair HVAC controls
- ECO 14, Infrared heaters
- ECO 15, Separate (automatic) light switches
- ECO 18, Replace exit signs bulbs with fluorescent bulb kits

ECO 1 involves reducing energy consumption by adequately insulating ductwork and roofs. Adequate insulation thickness is defined as the recommended thickness from Corps of Engineer guide specifications and ASHRAE Standard 90.1-1989. Buildings which require duct insulation include Buildings 101 and 735. Building 207 requires roof insulation.

ECO 5 involves replacing standard efficiency motors with high efficiency motors to save electrical energy and demand. Buildings appropriate for replacement of standard efficiency motors include

Buildings 101, 103, 207, 213, and 214.

ECO 7 involves turning off HW and DHW circulation pumps when they are not needed. HW pumps run continuously during the heating season. HW pumps could be shut off using optimization controls during unoccupied periods and when heating loads are met in the building. This will result in heating and electric energy savings. DHW circulation pumps operate continuously year round. Installing time clocks on these pumps could minimize operating time. Building 101 is the only building appropriate for providing hot water pump controls.

ECO 11 involves replacing twelve 1500-watt exterior quartz lamp fixtures with 400-watt high pressure sodium lamp fixtures to save energy. Replacing quartz bulbs with higher efficiency HPS bulbs will also have non-energy labor savings, because quartz bulbs have a shorter life than HPS bulbs.

ECO 12 involves installation of direct digital controls (DDC) in place of existing local loop controls. Many of the existing local loop controls operate poorly, over-condition spaces, and waste energy. New DDC would maintain proper temperature setpoints, reduce service calls for temperature related problems, and reduce energy consumption. Building 101 is the only building appropriate for providing DDC.

ECO 14 involves installing radiant heaters, in place of steam or gas unit heaters, for heating of warehouses. The new heaters will save energy over the present heaters due to reduction in indoor air temperatures, better combustion efficiency, and elimination of air circulation fans. Buildings appropriate for providing radiant heaters include Buildings 207, 400, and 401.

ECO 15 involves installation of occupancy sensor lighting controls. Currently, interior lighting is left on, either because no local switching is available or because people do not turn the lights off when they leave their offices for short periods of time. Providing occupancy sensor light switches can save energy. Buildings appropriate for providing separate (automatic) light switches include Buildings 101, 103, 213, and 935.

ECO 18 involves replacing incandescent exit sign light bulbs with fluorescent bulbs. This replacement will result in 272 kWh saved per year per fixture. Buildings appropriate for replacing exit sign bulbs include Buildings 101, 103, 207, 213, 400, 401, and 935.

Table 4-1 on page 4-4 provides an economic summary of MCA Project-1.

Results:

Annual Natural Gas Savings (MBtu)	6,919
Annual Electrical Energy Savings (kWh)	980,382
Annual Demand Savings (kW)	86
Annual Non-Energy Cost Savings	(\$607)
Total Annual Cost Savings	\$57,327
Estimated Construction Cost	\$740,529
Analysis Period (years)	15
Simple Payback (years)	11.3
Savings-to-Investment Ratio (SIR)	1.1

Recommendation: Implement.

TABLE 4-1
MCA PROJECT-1 SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
ECO-1 Duct	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
ECO-1 Roof	0	108,540	4,109	4,479	21,957	0	0	21,957	419,503	1.2	19.1
ECO-5	11	71,225	0	243	1,816	1,102	0	2,918	37,154	1.2	12.7
ECO-7	0	124,564	233	658	4,271	0	0	4,271	9,868	4.6	2.3
ECO-12	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
ECO-14-Heat	0	263,425	2,007	2,906	16,090	0	0	16,090	166,198	1.3	10.3
ECO-15	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
ECO-18	7	63,860	0	218	1,635	748	(734)	1,649	10,296	2.5	6.2
TOTAL	86	974,092	6,671	9,994	56,008	8,843	(433)	64,418	735,360	1.1	11.4

4.3.3 MCA Project-2

This project, made up of only ECO 19, involves the replacement of office and warehouse light fixtures with more efficient fluorescent and high pressure sodium fixtures having approximately the same or higher illuminance levels. The savings determined by a previous study indicate the energy savings will justify the replacement cost. See Feasibility Study for Lighting Shared Energy Savings Project, Ft. McPherson and Ft. Gillem, Georgia for buildings to be incorporated into the project.

Results:

Annual Natural Gas Savings (MBtu)	0
Annual Electrical Energy Savings (kWh)	2,971,800
Annual Demand Savings (kW)	1,270
Annual Non-Energy Cost Savings	\$0
Total Annual Cost Savings	\$206,159
Estimated Construction Cost	\$2,380,795
Analysis Period (years)	15
Simple Payback (years)	11.5
Savings-to-Investment Ratio (SIR)	1.3

Recommendation: Implement.

4.3.4 Low-Cost/No-Cost Project-1

Premise:

This project, made up of only ECO-8, involves replacing shower heads and faucets with low-flow shower heads and faucets to minimize hot water consumption. Field measurements of existing showers indicate flows as high as 4.5 gallons per minute (gpm). This rate can be reduced to 1.5 gpm. Replacing shower heads and faucets can lower natural gas, water, and sewage charges. This ECO was applicable in Building 935.

Results:

Annual Natural Gas Savings (MBtu)	99
Annual Electrical Energy Savings (kWh)	0
Annual Demand Savings (kW)	0
Annual Non-Energy Cost Savings	\$550
Total Annual Cost Savings	\$1,010
Estimated Construction Cost	\$925
Analysis Period (years)	15
Simple Payback (years)	0.9
Savings-to-Investment Ratio (SIR)	13.5

Recommendation: Implement.

4.4 NAF PROJECTS

ECOs evaluated for NAF facilities were grouped together for consideration by NAF related organizations. Table 4-2 on page 4-7 provides an economic summary of projects which should be funded by NAF facility organizations to lower utility consumptions. The summary indicates there are 2 ECOs with an SIR greater than 1.0 and a simple payback less than 8 years, for a total construction cost of \$115,416. The combined results of the best 2 ECO projects are presented below.

Results:

Annual Natural Gas Savings (MBtu)	3,829
Annual Electrical Energy Savings (kWh)	178,913
Annual Demand Savings (kW)	9
Annual Non-Energy Cost Savings	(\$906)
Total Annual Cost Savings	\$22,468
Estimated Construction Cost	\$115,416
Analysis Period (years)	25
Simple Payback (years)	5.1
Savings-to-Investment Ratio (SIR)	4.3

Recommendation: Implement the two ECOs listed.

TABLE 4-2
NAF ECONOMIC SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
ECO-14 Seals	0	100,073	3,829	4,170	20,433	0	0	20,433	102,705	4.5	5.0
ECO-18	9	78,840	0	269	2,010	924	(906)	2,028	12,711	2.5	6.3
TOTAL	9	178,913	3,829	4,439	22,443	924	(906)	22,461	115,416	4.3	5.1

SECTION 5.0

SUMMARY AND RECOMMENDATIONS

5.1 SUMMARY

5.1.1 ECOs EVALUATED

Seventeen ECOs were identified in the SOW to be evaluated for selected buildings at Fort Gillem. During the entrance interview conference, ECO 18 was included, to be evaluated for all buildings specified for ECO 15, lighting controls. ECO 18 involves replacing incandescent exit signs light bulbs with fluorescent bulbs. After discussions with DEH, it was also decided to include the results of previous lighting studies (see Section 1.6), which were originally evaluated as shared energy savings projects. The results were included as ECO 19; economics are based on design, bid, and construction, direct by the Government rather than by an energy service contractor under a shared energy savings contract.

Subsequent to the field survey, each ECO for each building was reviewed to determine if it was technically feasible. ECOs which are not technically feasible were eliminated from further evaluation. In addition, as the facilities were surveyed, some ECOs included in the SOW were found to apply to buildings not identified in the ECO matrix (Annexes B and C). With the approval of DEH, these buildings were added to the original list.

5.1.2 RESULTS

Of the individual ECOs evaluated, 12 projects had an SIR greater than 1.0 (see Table 5-1 on page 5-2). Those ECOs having an SIR greater than 1.0 are by definition economically feasible. The total estimated construction cost for the 12 projects is \$4,455,080.

Table 5-1 on page 5-2 lists the economic summary of each individual ECO, in ECO number order. Table 5-2 on page 5-4 lists the economic summary of each individual ECO, in order by SIR.

All ECOs having an SIR less than 1.0 were dropped from further analysis. These included:

- - ECO 1, Pipe Insulation
- ECO 1, Wall Insulation
- ECO 2, Insulated Windows
- ECO 3, Weatherstripping and Caulking
- ECO 6, Economizers
- ECO 9, Heat Reclaim from Hot Refrigerant Gas
- ECO 10, Prevent Air Stratification
- ECO 13, Thermal Storage

TABLE 5-1
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
1-Pipe Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking		NO BUILDINGS WITH SIR GREATER THAN 1.0									
4-HW Temp		NOT APPLICABLE - MEASUREMENT ONLY									
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
8-Shower/Faucet	0	0	99	99	460	0	550	1,010	925	13.5	0.9
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
14-IR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3

TABLE 5-1
ECONOMIC SUMMARY OF ECOs, LISTED BY ECO NUMBER

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
16-Demand		NOT APPLICABLE									
17-Boiler		NOT APPLICABLE									
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

TABLE 5-2
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
8-Shower/Faucet	0	0	99	99	460	0	550	1,010	925	13.5	0.9
7-HW Pump Control	0	124,564	233	658	4,264	0	0	4,264	11,003	4.6	2.6
1-Duct Insulation	0	4,596	38	54	295	0	0	295	2,040	3.0	6.9
12-HVAC Controls	57	285,187	302	1,274	8,683	5,852	127	14,661	57,547	2.9	3.9
14-Dock Seals	0	110,603	4,234	4,611	22,729	0	0	22,729	113,516	2.8	5.0
18-Exit Signs	16	142,700	0	487	3,653	1,672	(1,640)	3,686	23,007	2.5	6.2
11-Street Lights	0	4,928	0	17	126	0	174	300	2,682	1.7	8.9
14-JR Heaters	0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3
19-Lighting Retrofit	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
5-High Eff. Motor	11	71,225	0	243	1,816	1,102	0	2,718	37,154	1.2	12.7
1-Roof Insulation	0	186,795	7,187	7,824	38,327	0	0	38,327	731,391	1.2	19.0
15-Light Control	11	47,766	(18)	145	1,136	1,141	0	2,277	30,072	1.1	13.2
TOTAL	1,365	5,638,109	24,935	44,166	260,367	140,145	(789)	399,223	4,455,080	1.4	11.1
4-HW Temp		NOT APPLICABLE									
1-Pipe Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
3-Caulking		NO BUILDINGS WITH SIR GREATER THAN 1.0									
1-Wall Insulation		NO BUILDINGS WITH SIR GREATER THAN 1.0									
2-Insulate Windows		NO BUILDINGS WITH SIR GREATER THAN 1.0									

TABLE 5-2
ECONOMIC SUMMARY OF ECOs, LISTED BY SIR

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
9-Heat Reclaim		NO BUILDINGS WITH SIR GREATER THAN 1.0									
6-Economizer		NO BUILDINGS WITH SIR GREATER THAN 1.0									
17-Boiler		NOT APPLICABLE									
16-Demand		NOT APPLICABLE									
10-Air Stratification		NO BUILDINGS WITH SIR GREATER THAN 1.0									
13-Thermal Storage		NO BUILDINGS WITH SIR GREATER THAN 1.0									

5.1.3 ENERGY PROJECT DEVELOPMENT

Individual ECOs were grouped into projects for possible funding under three main funding areas:

- Energy Conservation Investment Program (ECIP) projects
- Non-ECIP, including Quick Return on Investment Program (QRIP), Military Construction Army (MCA) program, and low-cost/no-cost projects
- Non-Appropriated Funds (NAF) Projects, funded by agencies and organizations maintaining clubs, commissary, exchange, and related buildings.

Following the Interim Submittal, Fort McPherson DEH provided a list of buildings which have reimbursed utilities (NAF buildings) at Fort Gillem. These facilities were eliminated from the possible ECIP funded projects. Elimination of these facilities required the ECIP projects recommended in the Interim Submittal be revised to take into account lower individual ECO construction cost estimates.

At Fort Gillem, no projects were evaluated for ECIP funding because the construction cost of all combined economically feasible projects was less than \$300,000.

At Fort Gillem, two projects were evaluated for MCA funding:

- MCA Project 1, including the following ECOs:
 - ECO 1, Add duct insulation
 - ECO 1, Add roof insulation
 - ECO 5, Install high efficiency electric motors
 - ECO 7, Control hot water circulation pumps
 - ECO 11, Replace street lights
 - ECO 12, Revise or repair HVAC controls
 - ECO 14, Provide infrared heaters
 - ECO 15, Separate (automatic) light switches
 - ECO 18, Replace exit signs bulbs with fluorescent bulb kits.
- MCA Project 2 - ECO 19, previous lighting review study, for light fixture replacement.

ECO 8, install low flow shower and faucet fixtures, was evaluated as a low-cost or no-cost ECO to be performed by in-house maintenance staff.

ECOs evaluated for NAF facilities which have an SIR less than 1.0 and a simple payback less than 8 years, were lumped together for consideration by NAF related organizations.

Table 5-3 on page 5-7 provides an economic summary of projects which should be considered for funding. Overall, there are \$3,117,080 of potential Non-ECIP projects, and \$115,416 of potential NAF projects to fund.

TABLE 5-3
PROJECTS ECONOMIC SUMMARY

ECO NO.	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND CREDIT (\$)	NON-ENERGY SAVINGS (\$)	TOTAL COST AVOID (\$)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
MCA Project-1	86	974,092	6,671	9,994	56,008	8,843	(433)	64,418	735,360	1.1	11.4
MCA Project-2	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5
Low-Cost/ No-Cost ECO	0	0	99	99	460	0	550	1,010	925	13.5	0.9
NAF ECO-14 Seals	0	100,073	3,829	4,170	20,433	0	0	20,433	102,705	4.5	5.0
NAF ECO-18	0	78,840	0	269	2,010	924	(906)	2,028	12,711	2.5	6.3
TOTAL	1,365	4,124,805	10,599	24,666	179,358	140,145	(789)	294,048	3,526,544	1.6	10.6

5.2 RECOMMENDATIONS

- It is recommended the Army fund the construction of the two MCA projects to lower facility utility consumption, in order to meet energy reduction goals of the Department of Defense.
- It is recommended Ft. Gillem DEH complete the low-flow shower and faucet fixture project (ECO-8) in-house, using operation and maintenance money and local government staff.
- It is recommended the results of the energy evaluations on NAF buildings be provided to the related organizations for possible funding.

APPENDIX A

SCOPE OF WORK AND CONFIRMATION NOTICES

18 June 1991

SCOPE OF WORK
FOR AN
ENERGY SAVINGS OPPORTUNITY SURVEY
ENERGY ENGINEERING ANALYSIS PROGRAM

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7. WORK TO BE ACCOMPLISHED
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 - 7.2 Perform a Limited Site Survey
 - 7.3 Combine ECOs into Recommended Projects
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- A - ENERGY CONSERVATION OPPORTUNITIES
- B - DETAILED SCOPE OF WORK - FT. GILLEM, GA
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- D - EXECUTIVE SUMMARY GUIDELINES
- E - LIST OF MILESTONE DATES
- F - SUPPLEMENTAL LIST OF INFORMATION
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1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Perform a limited site survey of selected buildings or areas to insure that any methods of energy conservation which are practical and have not been evaluated in any previous energy study have been considered and the results documented.

1.2 Evaluate selected ECOs to determine their energy savings potential and economic feasibility.

1.3 Group recommended ECOs into projects for implementation as detailed herein.

1.4 Prepare a comprehensive report to document the work performed, the results and the recommendations.

2. GENERAL:

2.1 Other studies performed under the EEAP have been performed at this installation. Criteria for both the study and the resulting documentation has changed since the previous study was completed. This study is intended to consider specific ECOs in buildings and areas that may have been overlooked previously or recently identified.

2.2 The information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study.

2.3 The AE shall ensure that all methods of energy conservation which will reduce the energy consumption of the installation in compliance with the Energy Resources Management Plan including those listed in Annex A have been considered and documented. All methods of energy conservation which are reasonable and practicable shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination. A list of general energy conservation opportunities to be used when evaluating specific buildings or areas is included as Annex A to this scope. This list shall be considered and the evaluation of each ECO documented in the report. This list is not intended to be restrictive but only to assure that basic and generally repetitive opportunities are addressed in the report. Some of the energy conservation opportunities may not be applicable to the specific building or area at these installations. A statement to that effect is all that is required.

2.4 The study shall include the energy consuming buildings or areas listed in Annex B and Annex C. Annex B contains a building/eco check list specifically for Ft. Gillem, GA and Annex C contains a building/eco check list specifically for Ft. McPherson, GA. The work in the areas may be reduced somewhat by building repetition.

2.5 The study shall consider the use of all energy sources. The energy sources may include electricity, natural gas, liquefied petroleum gas, bulk oil, other oil products, steam when

procured, gasoline, coal, solar, etc.

2.6 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from CEHSC-FU, dated 25 April 1988, and the latest revision from CEHSC-FU-P, establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

3. PROJECT MANAGEMENT:

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer at each installation will designate an individual who will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conference.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and

accomplishment of the work. The AE shall coordinate with the installation point of contact on any requirements for access to secure areas.

3.6 Records.

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed, and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall thoroughly describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

- a. Schedules.
- b. Names of energy analysts who will be conducting the site survey.
- c. Proposed working hours.
- d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall include a thorough briefing describing the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS: All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, superintendence and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION: All energy conservation opportunities which the AE has

considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than \$200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than four years. For ECAM and family housing projects, the \$200,000 limitation may not apply; and in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have a SIR greater than one. For all projects meeting the above criteria, shall be arranged as specified in paragraph 2.8.1 and provided with the following documentation: life cycle cost analysis summary sheet(s), description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which normally do not meet ECIP criteria, but which have an overall SIR greater than one shall be documented. The life cycle cost analysis summary sheet shall be completed through and including line 7 for all projects or ECOs. Each shall be analyzed to determine if they are feasible even if they do not meet ECIP criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs in this category, the life cycle cost analysis summary sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project, and the simple payback period shall be included in the report. Additionally, these projects shall be grouped in accordance with the requirements of the Government's representative, for one of the following categories:

- a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over \$100,000 and a simple payback period of two years or less.
- b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than \$100,000 and a simple payback period of four years or less.
- c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than \$3,000 and a simple payback period of four years or less.

The above programs are all described in detail in AR 5-4, Change No. 1.

- d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than \$200,000 and a simple payback period of four to twenty-five years.

- e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing can perform using his resources.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they

were rejected.

6. DETAILED SCOPE OF WORK: The general Scope of Work is intended to apply to contract efforts for all Army installations included under this contract except as modified by the detailed Scope of Work for each individual installation. The detailed Scope of Work is contained in Annexes B and C.

7. WORK TO BE ACCOMPLISHED:

7.1 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The necessary data required for these projects may not be available, requiring the AE to visit the installation to obtain any necessary information. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data. For ECOs which would significantly affect the existing heating, ventilating, and air conditioning (HVAC) system (such as adding economizer cycles, repairing or revising HVAC controls, and thermal storage) the AE is required to run a computer simulation to analyze the system and to determine the energy savings. The computer program shall use established weather data files and may perform calculations on a true hour-by-hour basis or may condense weather files and the number of calculations in to several "typical" days per month. The AE shall submit a sample computer run with an explanation of all input and output data and a summary of program methodology and energy evaluation capabilities for approval by the Contracting Officer prior to use of the program for analysis. The A-E shall use the latest version of the Life Cycle Cost in Design (LCCID) computer program. This program is available from the BLAST Support Office located at the University of Illinois. The BLAST Support Office can be reached at 1-800-UIBLAST.

7.2 Perform a Limited Site Survey. The AE shall conduct a limited site survey to evaluate the ECOs in the buildings or areas listed in Annex B and Annex C. These lists are not intended to be restrictive but only to assure that these opportunities, as a minimum, are considered, discussed and documented in the report. The AE may be aware of other ECOs not included in Annex B and Annex C that will produce energy, manpower or dollar savings. These should be evaluated the same as the other ECOs. Each of the items shall be considered and discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall obtain all the necessary data to evaluate the ECOs by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms at part of the report. All test and/or measurement equipment shall be

properly calibrated prior to its use.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraph 5.1 and 5.2. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Prefinal Submittal per paragraph 7.4.2.

7.4 Submittals, Presentations, and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall be prepared using Wordperfect. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, sub-sections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other Government personnel. The AE shall prepare slides or view graphs showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose. All formal presentations and review meetings will be held at Fort McPherson.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within. A complete and separately bound report shall be prepared for each installation.

7.4.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. The synergistic effects of any related ECOs shall have been determined and their savings calculations adjusted accordingly. The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study (see Annex D) , (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) documentation for the recommended projects, and (d) appendices to include the detailed calculations and all backup material. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. The prefinal report shall also include copies of all correspondence and meeting minutes.

7.4.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages. An electronic copy of the final report shall be given to Savannah District. A hard copy of any original material or graphics that is not in diskette form shall also be given to Savannah District.

ANNEX A
ENERGY CONSERVATION OPPORTUNITIES

1. Insulation (wall, roof, pipe, duct, etc) The AE shall be provided with an asbestos survey which will identify asbestos insulation
2. Insulated glass or double glazed windows
3. Weatherstripping & caulking
4. Measure and record the water temperature of hot water heaters *
5. Electric motors - Check the adequacy of the size and efficiency of HVAC equipment with motors 10 hp or greater and provide recommendations. *
6. Add economizer cycles (dry bulb) and evaluate minimum outside air levels
7. Control hot water circulation pump (consider OA reset and optimization controls)
8. Install shower flow restrictors and faucet flow resistors
9. Heat reclaim from hot refrigerant gas
10. Prevent air stratification
11. Reduce street lights (evaluate existing survey and provide recommendation)
12. Revise or repair HVAC controls **
13. Thermal storage
14. Air curtains, loading dock seals, and infrared heaters
15. Separate switches to control lighting arrangements (consider automatic controls)
16. Investigate post demand usage. (Provide recommendation on ways to reduce the peak)
17. Evaluate boiler operation. Compare continuous 24 hour operation versus the current 16 hour per day .

* Investigate for all buildings that are surveyed.

** If replacement of HVAC controls for large air handling unit systems is recommended, the controls shall be revised in accordance with COE standard control panel design.

The matrices in Annex B and Annex C further delineate which ECOs are applicable to each building.

ANNEX B
DETAILED SCOPE OF WORK
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

1. General: The detailed scope of work provided here-in-after describes site specific requirements for an "Energy Savings Opportunity Survey" at Ft. Gillem, Georgia.
2. Scope: The Project Manager for this study shall provide all necessary work to complete the detailed energy audit as defined by the General Scope of Work and described in this and other attached annexes.
3. Detailed Requirements: All detailed requirements selected at Ft. Gillem for the purposes of this study shall specifically include the facilities and ECOs identified by the DEH as shown in this annex.
 - 3.1 In paragraph 3.7 "Interviews" - interviews are to be scheduled at least (2) two weeks in advance by the A-E.
 - 3.2 The installation reserves the right to substitute other like buildings for those designated to be surveyed.
 - 3.3 The Fort Gillem point of contact (POC) is Mrs. Terry Seabrook (404) 752-3076/3807.
 - 3.4 The A-E is to provide a cost estimate for each low cost/no cost project to reflect the cost of "contracting out".
 - 3.5 For this study M (as in MBTU) is 10⁶.
 - 3.6 Provide a glossary and a table of contents in all volumes.
 - 3.7 The A-E is responsible for furnishing the labor, materials, and equipment required for making all the necessary prints of the building plans. The DEH will furnish space and electricity for the AE's reproduction equipment. The AE shall coordinate the hours of operation with the installation point of contact.
 - 3.8 In paragraph 7.1 "Evaluate selected ECOs" - The A-E is required to run a computer simulation to analyze those ECOs which involve adding economizer cycles, repairing HVAC controls, and thermal storage.
4. The Project Manager, for this study, shall make direct distribution of all required submittals and documentation in the numbers of copies as required. Submittals shall be sent to each agency as provided in the list shown in Annex G.
5. Reference Documents: The Project Manager for this study shall be given all the reference

information and data as mentioned throughout the Scope of Work. The data will be provided upon request from the Project Manager to the DEH. The reference material shown in Annex F shall be furnished upon request from the Project Manager for this study to Savannah District Project Manager.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
*101 (ADMIN)	X	X	X	X	X	X	X		X			X			X		
102 (MAINT)				X	X					X							
103 (FIRE STA)				X	X										X		
133 (O CLUB)				X	X				X								
207 (STOR)				X	X					X				X	X		
213 (CID BLDG)				X	X										X		
214 (COMMISS)				X	X					X				X			
308 (STOR)				X	X												
400 (DOL)				X	X					X				X	X		
401 (81st ARC)				X	X					X				X	X		
403T (DIN FAC)				X	X												X
*505 (STOR)**				X	X												X
506 (STOR)																	X
507 (STOR)																	X
508 (STOR)																	X
509 (STOR)																	X
510 (STOR)																	X
511 (STOR)																	X
512 (STOR)	X	X	X	X	X					X				X	X		
513 (STOR)																	X
514 (STOR)																	X
701T (ADMIN)	X	X	X												X		X
702T (ADMIN)	X	X	X												X		X
703T (ADMIN)	X	X	X												X		X
704T (ADMIN)	X	X	X	X	X										X		X

ECO 27 is postwide.

T Denotes that the building is temporary construction.

* This building is secure or has secure areas that will require an escort.

** Bldg 505 is typical for all the 500 block building (except 512). Only survey this typical building.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. GILLEM, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
705T ADMIN***	X	X	X												X		X
706T (ADMIN)	X	X	X												X		X
707T (ADMIN)	X	X	X												X		X
708T (ADMIN)	X	X	X												X		X
709T (ADMIN)	X	X	X												X		X
710T (ADMIN)	X	X	X												X		X
735T (CHAPEL)	X	X	X	X	X												
918T (BOWLING)				X	X										X		
922 (ADMIN)	X	X	X	X	X										X		
923 (STOR)	X	X	X	X	X										X		
935 (FIT CTR)				X	X										X		
942T (DIN FAC)				X	X	X	X		X								

ECO 27 is postwide.

T Denotes that the building is temporary construction.

*** Bldg 705 is typical for buildings 701 thru 710. Only survey this typical building.

ANNEX C
DETAILED SCOPE OF WORK
ENERGY SAVINGS OPPORTUNITY SURVEY - FT.MCPHERSON, GA

1. General: The detailed scope of work provided here-in-after describes site specific requirements for an "Energy Savings Opportunity Survey" at Ft. McPherson, Georgia.
2. Scope: The Project Manager for this study shall provide all necessary work to complete the detailed energy audit as defined by the General Scope of Work and described in this and other attached annexes.
3. Detailed Requirements: All detailed requirements selected at Ft. McPherson for the purposes of this study shall specifically include the facilities and ECOs identified by the DEH as shown in this annex.
 - 3.1 In paragraph 3.7 "Interviews" - interviews are to be scheduled at least (2) two weeks in advance by the A-E.
 - 3.2 The installation reserves the right to substitute other like buildings for those designated to be surveyed.
 - 3.3 The Fort McPherson point of contact (POC) is Mrs. Terry Seabrook (404) 752-3076/3807.
 - 3.4 The A-E is to provide a cost estimate for each low cost/no cost project to reflect the cost of "contracting out".
 - 3.5 For this study M (as in MBTU) is 10⁶.
 - 3.6 Provide a glossary and a table of contents in all volumes.
 - 3.7 The A-E is responsible for furnishing the labor, materials, and equipment required for making all the necessary prints of the building plans. The DEH will furnish space and electricity for the AE's reproduction equipment. The AE shall coordinate the hours of operation with the installation point of contact.
 - 3.8 In paragraph 7.1 "Evaluate selected ECOs" - The A-E is required to run a computer simulation to analyze those ECOs which involve adding economizer cycles, repairing HVAC controls, and thermal storage.
4. The Project Manager, for this study, shall make direct distribution of all required submittals and documentation in the numbers of copies as required. Submittals shall be sent to each agency as provided in the list shown in Annex G.
5. Reference Documents: The Project Engineer for this study shall be given all the reference

information and data as mentioned throughout the Scope of Work. The data will be provided upon request from the Project Manager to the DEH. The reference material shown in Annex F shall be furnished upon request from the Project Manager for this study, to Savannah District Project Manager.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MCPHERSON, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
022 (ADMIN)	X	X	X	X	X			X				X					
027 (GUEST)	X	X	X	X	X			X									
028 (GUEST)	X	X	X	X	X			X									
040 (UPH)	X	X	X	X	X			X									
041 (ADMIN)	X	X	X	X	X										X		
042 (CHAPEL)	X	X	X	X	X												
056 (UPH)				X	X			X				X			X		
058 (UPH)				X	X			X				X			X		
060 (UPH)				X	X			X				X			X		
061 (LAB)	X	X	X	X	X												
062 (UPH)				X	X			X				X			X		
100 (DENTAL)	X	X	X	X	X												
101 (DENTAL)	X	X	X	X	X							X			X		
102 (POLICE)	X	X	X	X	X												
105 (LAB)	X	X	X	X	X												
109T (GUEST)	X	X	X	X	X			X									
111 (ADMIN)	X	X	X	X	X												
112 (ADMIN)	X	X	X	X	X												
114 (ADMIN)	X	X	X	X	X												
116 (ADMIN)	X	X	X	X	X												
117 (CLASS RM)	X	X	X	X	X												
118 (ADMIN)	X	X	X	X	X												
120 (ADMIN)	X	X	X	X	X												
121 (ADMIN)	X	X	X	X	X												
122 (ADMIN)	X	X	X	X	X												

ECO 27 is postwide.

T Denotes that the building is temporary construction.

ECO/BUILDING CHECK LIST
ENERGY SAVINGS OPPORTUNITY SURVEY - FT. MCPHERSON, GA

BUILDING	ECO NUMBER																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
124 (ADMIN)	X	X	X	X	X												
126 (ADMIN)	X	X	X	X	X												
131 (CLINIC)				X	X	X											
155 (NCO CLUB)	X	X	X	X	X												
168 (ADMIN)				X	X			X				X					
170 (CLINIC)				X	X	X	X		X						X		
171 (CLINIC)				X	X	X	X		X						X		
178 (TRAINING)	X	X	X	X	X												
179 (CLASS RM)	X	X	X	X	X												
181 (ADMIN)	X	X	X	X	X				X			X			X		
184 (STOR)	X	X	X	X	X	X	X								X		
187 (PX MAINT)				X	X								X				
*200 (ADMIN)				X	X				X				X				
206 (ADMIN)				X	X		X										
246 (ADMIN)				X	X	X						X	X		X		
250 (LIBRARY)				X	X							X					
358T (ADMIN)	X	X	X	X	X	X						X					
360 (LAB)				X	X				X					X			
*363 (MAINT)				X	X										X		
366 (STOR)				X	X					X				X	X		
400 (MOR SPT)	X	X	X	X	X										X		
401 (BOWLING)				X	X										X		
500 (DIN FAC)				X	X	X	X		X			X					
514 (DAY CARE)				X	X	X											
522 (GUEST)	X	X	X	X	X				X								

ECO 27 is postwide.

T Denotes that the building is temporary construction.

* This building is secure or has secure areas that will require an escort.

ANNEX D
EXECUTIVE SUMMARY GUIDELINE

1. Introduction
2. Building Data (types, number of similar buildings, sizes, etc.)
3. Present Energy Consumption.
 - o Total Annual Energy Used.
 - o Source Energy Consumption.
 - Electricity - KWH, Dollars, BTU
 - Fuel Oil - GALS, Dollars, BTU
 - Natural Gas - THERMS, Dollars, BTU
 - Propane - GALS, Dollars, BTU
 - Other - QTY, DOLLARS, BTU
 - o Energy Consumption of the buildings in this study as compared to the basewide consumption.
4. Historical Energy Consumption.
5. Energy Conservation Analysis.
 - o ECOs Investigated.
 - o ECOs Recommended.
 - o ECOs Rejected.
 - o ECIP Projects Developed. (Provide list)*
 - o Non-ECIP Projects Developed. (Provide list)*
 - o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.
6. Energy and Cost Savings.
 - o Total Potential Energy and Cost Savings.
 - o Percentage of Energy Conserved.
 - o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX E
LIST OF MILESTONE DATES

<u>Milestone</u>		<u>Approximate Date</u>
1. Interim Submittal		NTP + 180 days
2. AE receives comments on Interim Submittal		NTP + 218 days
3. Interim Presentation and Review Conference		NTP + 225 days
4. Prefinal Submittal	JULY 24, 1992	NTP + 249 days
5. AE receives comments on Prefinal Submittal	AUGUST 7, 1992	NTP + 271 days
6. Prefinal Presentation and Review Conference	AUGUST 20, 1992	NTP + 285 days
7. Operational and Maintenance Briefing		NTP + 294 days
8. Final Submittal	SEPTEMBER 4, 1992	NTP + 299 days

ANNEX F
SUPPLEMENTAL LIST OF INFORMATION

1. Energy Resources Management Plan
2. ETL 1110-3-254 dated 25 Aug 76. - Use of electric Power for Comfort Space Heating
3. Architectural and Engineering Instructions.
4. Energy Conservation Investment Program (ECIP) Guidance dated 25 April 1988, and the latest revision with current energy prices and discount factors for the life cycle cost analysis.
5. TM 5-785 dated 1 Jul 78. - Engineering Weather Data
6. TM 5-800-2 dated Jun 85. - Cost Estimates Military Construction
7. TM 5-800-3 dated Jul 82. - Project Development Brochure
8. TM 5-802-1 dated 31 Dec 86. - Economic studies for Military Construction Design - Applications
9. TM 5-815-3 dated Sep 90. - HVAC Control Systems (Draft)
10. AR 415-15 dated 1 Jan 84. - Military Construction Army (MCA) Program Development
11. AR 415-17 dated 15 Mar 80. - Cost Estimating for Military Programming
12. AR 415-20 dated Jan 82. - Project Development and Design Approval
13. AR 415-28 dated 1 Dec 81. - Department of the Army Facility Classes and Construction Categories (Category Codes)
14. AR 415-35 dated 15 Oct 83. - Minor Construction, Emergency construction, and Replacement of Facilities Damaged or Destroyed
15. AR 420-10 dated 3 Aug 87. - Management of Directorates of Engineering and Housing
16. AR 11-27 dated 13 Aug 89. - Army energy Program
17. AR 5-4, Change 1 dated 1 Aug 82. - Department of the Army Productivity Improvement Program

ANNEX G
TABLE OF REQUIRED SUBMITTALS

Copies of the reports shall be submitted directly to the Agencies listed below:

<u>AGENCY</u>	<u>REPORTS</u>	<u>EXECUTIVE SUMMARIES</u>	<u>FIELD NOTES</u>
Commander Fort McPherson ATTN: AFZA-FE (Seabrook) Fort McPherson, GA 30330	4	4	1*
Commander U.S. Army Engineer District, Mobile ATTN: CESAM-EN-CC (Battaglia) P.O. Box 2288, Mobile, Alabama 36628-0001	1**	1***	
Commander U.S. Army Engineer Division, South Atlantic ATTN: CESAD-EN-TE (Baggette) 77 Forsythe Street, SW Atlanta, GA 30335-6801	1	1	
Commander, FORSCOM ATTN: FCEN-CDI (Huff) Fort McPherson, GA 30330-6000	2	2	
Commander, HQUSACE ATTN: CEMP-ET (Torabi) Washington, DC 20314-1000		1***	
Commander, U.S. Army Logistics Evaluation Agency ATTN: LOEA-PL (Keath) New Cumberland Army Depot New Cumberland, PA 17070-5007		1***	
Commander U.S. Army Engineer District, Savannah ATTN: CESASEN-PI-9 (Clowser) P.O. Box 889, Savannah, GA 31402	4	4	1*

* Required at the Interim submittal only

** Submit only the prefinal report with the final report correction pages inserted

*** Submit after all the corrections have been made

CONFERENCE NOTES

DATE: 18 June 1991

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 14 June 1991

PLACE OF CONFERENCE: DEH Conference Room, Building T-368
Ft. McPherson, Georgia

SUBJECT: Pre-negotiation Meeting

ATTENDEES: Alfred Clowser, Savannah District COE, (912) 944-5625, FAX 944-5442
Denise Williams, Savannah District COE, (912) 944-5530
Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697
Pawn Chulavatr, E M C Engineers, Inc., (404) 952-3697
Terry Seabrook, DEH Ft. McPherson, (404) 752-3076, FAX 752-4193
Don Heldt, DEH Ft. McPherson, (404) 669-7163
B.V. Sheth, DEH Ft. McPherson, (404) 752-2071
Reg Allen, DEH Ft. Gillem, (404) 363-5270
Jim Mathis, DEH Ft. McPherson, (404) 752-3117

The following is a summary of the items discussed, the comments made, and the discussion made during the conference:

Mr. Clowser discussed the contractual portion of the work and informed EMC to deliver the submittal by UPS to 100 Oglethorp Street, Savannah, GA 31401. Mr. Clowser explained if EMC has any technical questions to talk to Denise Williams at the Savannah District COE.

Mr. Clowser explained survey periods should be coordinated with Terry Seabrook.

Mr. Lundstrom prepared a list of questions for clarification of the scope of work, as follows:

Statement of Work, Paragraph:

- 2.3 All methods of energy conservation which are reasonable and practicable shall be considered. Does this include items above and beyond Annex A?

Answer: General recommendations will be provided when EMC recognizes an opportunity.

2.10 Please explain ECAM. Does it apply to this project?

Answer: The ECAM does not apply to this project.

7.1 Discuss the number and type of computer energy simulations. Discuss acceptable computer energy simulation programs.

Answer: Par. 3.9 in Annex B & C takes precedent over par. 7.1 in the SOW on computer modeling. EMC will submit computer program descriptions along with the fee proposal.

7.2 What data is available from previous studies?

Answer: No data exists from previous studies.

Annex B, Paragraph:

3.4 Do we need to prepare two LCCA for the two cost estimates?

Answer: The DEH has limited time to spend on site construction. EMC will prepare one LCCA, unless EMC recognizes an opportunity for a low cost/no cost ECO to be performed in-house then; in that event, two LCCAs will be prepared.

3.7 Can EMC invoice monthly for partial payments?

Answer: Yes.

3.8 Is DEH willing to supply enough blueline paper? $89 \text{ bldgs} * 25 \text{ sheets per bldg} = 2225$ sheets of blueline paper.

Answer: Ft. McPherson will not supply blueline machine nor paper. EMC can bring a blueline machine on post and Ft. McPherson will provide working space. Mrs. Seabrook will check on refiling of prints.

ECO list, Paragraph:

1. Do you want EMC to identify potential asbestos insulation? Sample, test, and log? Are there any asbestos abatement project in funding cycles?

Answer: EMC will use Ft. McPherson's list of buildings with asbestos.

2. Do you want to consider double glazing, and various types of shaded or reflective glass?

Answer: No; insulation only.

8. Do you want us to take volt, amp, power factor, kW, kVAR, and kVA readings on each motor? Motors over 5 hp?

Answer: Yes; 10 hp and larger.

9. When we say economizer cycles, do you want EMC to evaluate modifying the HVAC systems to add duct work, dampers, and controls?

Answer: Yes; modify the HVAC systems to add duct work, dampers, and controls.

Or do you want to only modify controls on HVAC system with ducts with 100% OA and RA capability?

Answer: No.

What about evaluation of required minimum OA ventilation?

Answer: Yes; evaluate minimum OA ventilation.

10. Is HW circulation pumps referring to domestic HW or space heating circulation pumps? What type HW circulation controls do you want us to consider? Timeclocks, EMCS, OA reset and optimization controls?

Answer: "HW circulation pumps" refers to domestic HW and space heating circulation pumps. HW circulation controls will include OA reset.

11. Do you want EMC to consider tank or tankless DW heaters?

Answer: Delete from project.

12. Do you want EMC to also consider faucet flow resistors on sinks?

Answer: Yes.

17. Do you want EMC to also consider retrofitting new lamp types or fixtures?

Answer: EMC will survey and make a recommendation.

22. Do you want EMC to test all the HVAC controls to see if they need repair?

Answer: EMC will make recommendations. Buildings 101, 102, and 133 at Ft. Gillem and Buildings 65 and 184 at Ft. McPherson are removed from the project.

How do you want to handle possible controls work to be done under future shared energy savings contract, versus footnote in Annex A regarding HVAC controls to be COE standard control panel design?

Answer: EMC will perform the survey with regard to Annex A, HVAC controls to be COE standard control panel design.

26. Do you want EMC to consider ultrasonic and passive infrared automatic controls?

Answer: Yes.

27. Please expand on the description of "investigate post demand usage."

Do you want EMC to do power metering on buildings and loads? How many buildings and loads?

Answer: No metering. EMC will use a simple approach to evaluate and reduce post electric demand.

28. Please expand on the description of shutdown boilers versus continuous operation?

Answer: Shutdown boilers may cause higher maintenance than continuous operation.

- ** Are all the buildings listed in the "ECO/Building Check List" ?

Answer: Yes.

Other ECOs to consider:

Steam trap ECO's, steam trap survey?

Answer: No.

Annex E, Paragraph:

What is the preliminary estimate of dates?

Answer: Mr. Clowser will discuss these deadlines with EMC.

Annex F, Paragraph:

- e. Do you want EMC to test boiler combustion efficiency?

Answer: Delete from the project.

General:

1. Are there any secure areas where we'll need escorts?

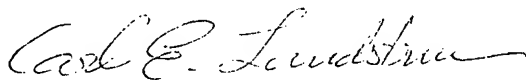
Answer: Yes; Buildings 200 and 363 at Ft. McPherson and Buildings 101, 213, and 505 at Ft. Gillem.

2. Are there any areas which will require asbestos suits and respirators?

Answer: No.

3. What type and age of hospital are buildings 170 and 171?

Answer: Buildings 170 and 171 are clinic type buildings.



Carl E. Lundstrom, P.E.

CONFIRMATION NOTICE

Confirmation No. 1

EMC #P30F.010

DATE: 24 June 1991
To/From: Denise Williams Phone # (912) 944-5530
Representing: Savannah District, Corps of Engineers

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

NOTICE
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

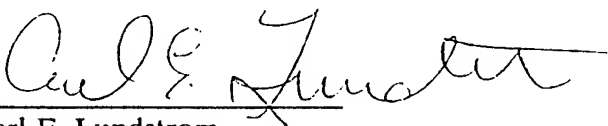
SUBJECT: Scope of Work Clarification

The following is a summary of the items discussed, the comments made, and the decisions made during the telephone conversation:

This is to confirm a telephone conversation on 24 June 1991 between Ms. Denise Williams and Mr. Carl Lundstrom regarding clarification of the Scope of Work dated 18 June 1991 for the above referenced project.

Mr. Lundstrom asked Ms. Williams if she could identify the scope of work paragraph section that described the "Operational and Maintenance Briefing" listed in Annex E, item 7.

Ms. Williams explained there was no paragraph section listing the requirements of the Operational and Maintenance Briefing; however, the briefing was meant to be a basic briefing for the maintenance staff, to be given at Ft. McPherson, to discuss the results of the study. EMC would not have to prepare any additional submittals or training material for this briefing.


Carl E. Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 2

EMC #P30F.013

DATE: 8 August 1991

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO. N/A

NOTES

PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 7 August 1991

PLACE OF
CONFERENCE: U.S. Army Engineer Corps of Engineer
Savannah District Offices
Savannah, Georgia

SUBJECT: To discuss the Scope of Work, provide clarification, and general fact finding.

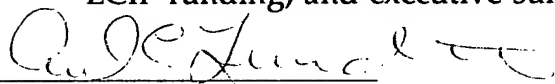
ATTENDEES: Al Clowser, Savannah District COE
Denise Williams, Savannah District COE
Lucie Hughes, Savannah District COE
Dick Hanna, Savannah District COE
Carl Lundstrom, E M C Engineers, Inc.

Mr. Lundstrom explained the detailed fee proposal breakdown, task-by-task, explaining the approach and level of detail involved in the survey, analysis, and report writing. The attendees discussed each task. The following is a summary of the items discussed, the comments made, and the resolutions made during the fact finding conference:

1. ECO 4: "Measure and record the water temperature of hot water heaters." EMC will only measure and document the domestic hot water temperatures. EMC will not evaluate any modification or change to the domestic water heaters.
2. ECO 6: "Add economizer cycles (dry bulb) and evaluate minimum outside air levels." EMC will not be required to take outside air (OA) flow measurements on existing HVAC systems. EMC will make engineering estimates of the OA

quantities from observations of the HVAC equipment and design drawings.

3. ECO 16: "Investigate post demand usage." The level of survey and analysis for this ECO will involve:
 - EMC will spend approximately one day at each site identifying potential electrical loads which could be shed, or generators which could be used to lower demand.
 - EMC will try to obtain demand information from the power company to identify the time and quantity of the peak electrical demand.
 - The A/E will provide a list of recommended ways the Fort should investigate lowering demand. No savings analysis or cost estimates will be required.
4. ECO 17: "Evaluate boiler operation." EMC will not be required to take any combustion efficiency tests for this ECO.
5. ECO project analysis, Section 7.3 of the Scope of Work: After combining ECO projects (after the interim submittal), EMC will not be required to reevaluate energy savings to take into account synergistic effects of multiple ECOs within a project and the effects of one project upon another. EMC will basically take the savings and cost estimates for ECOs directly from the interim submittal analysis and add them together to create proposed ECIP projects.
6. ECIP projects, Section 5.1: EMC will not be required to prepare any DD1391's or PDB's.
7. Non-ECIP projects, Section 5.2 of the Scope of Work: EMC will not be required to prepare any forms for QRIP, OSD PIF, or PECIP funding. EMC will only provide brief project descriptions and life cycle cost, and place the ECO in a category for non-ECIP funding.
8. The level of narrative text expected on the interim submittal is 40 pages, plus a few pages for a narrative summary. The final submittal will include approximately 10 more pages to describe project analysis, ECIP funding, non-ECIP funding, and executive summary.


Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately.

CONFIRMATION NOTICE

Confirmation No. 3

EMC #P30F.013

DATE: 8 August 1991

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORTS McPHERSON AND GILLEM, GEORGIA

CONTRACT NO. N/A

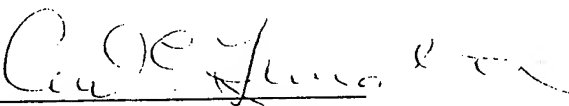
NOTICE

PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Clarifications to the scope of work.

This is to confirm a telephone conversation on 8 August 1991 between Denise Williams, Savannah District COE, and Carl Lundstrom, E M C Engineers, Inc., regarding clarifications to the scope of work.

- EMC will evaluate thermal storage for Buildings 200 and 246 using computer simulations analysis. EMC at their option may evaluate thermal storage for building 187 using computer simulations or hand calculations.
- EMC will evaluate HVAC economizers for Buildings 184, 246, and 500 using computer simulation analysis. EMC at their option may evaluate HVAC economizers for the other buildings noted in Annex B and Annex C, using computer simulations or hand calculations.



Carl E. Lundstrom, P.E.

If any portion of this confirmation notice is incorrect, please notify us immediately.

CONFIRMATION NOTICE

Confirmation No. 4

EMC #3105.000

DATE: 21 October 1991
To/From: Earl Jenkins
Savannah District COE

(912) 944-5629

PROJECT: ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORTS McPHERSON AND GILLEM, GEORGIA
CONTRACT NO. DACA21-91-C-0097

NOTES

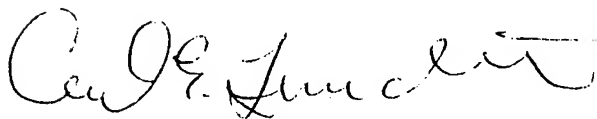
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Reaffirm earlier Confirmation Notices discussed with and confirmed
as accurate by Al Clowser.

This is to confirm a telephone conversation on 21 October 1991 between Earl Jenkins, Project Manager, Savannah District COE, and Carl E. Lundstrom, Project Manager, E M C Engineers, Inc.

1. Mr. Jenkins affirmed to Mr. Lundstrom that all the previous confirmation notices and conference notes prepared during contract negotiations are effective toward defining the scope of the project. Previous confirmation notices and conference notes include:

- Confirmation notice 1., 24 June 1991
- Confirmation notice 2., 8 August 1991
- Confirmation notice 3., 8 August 1991
- Conference notes, dated 18 June 1991



Carl E. Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 5

EMC #3105.000

DATE: 15 November 1991

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

NOTICE
PREPARED BY: Pawn Chulavatr
E M C Engineers, Inc.

DATE OF
CONFERENCE: 14 November 1991

PLACE OF
CONFERENCE: DEH Conference Room, Building T-368
Ft. McPherson, Georgia

SUBJECT: Entrance Interview

ATTENDEES: Earl Jenkins, Savannah District COE, (912) 944-5622, FAX 944-5442
Denise Williams, Savannah District COE, (912) 944-5530
Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697
Pawn Chulavatr, E M C Engineers, Inc., (404) 952-3697
Terry Seabrook, DEH Ft. McPherson, (404) 752-3076, FAX 752-4193
Jim Mathis, DEH Ft. McPherson, (404) 752-2207
Naresh Kapur, HQ FORSCOM, (404) 669-6731

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

Mrs. Seabrook welcomed everyone to the meeting. Mr. Jenkins introduced himself and explained the administrative portion of the project. Mr. Jenkins has replaced Mr. Alfred Clowser as the COE Project Manager. Mr. Jenkins requested that EMC show the dates of report revisions on the report covers. Mr. Jenkins requested that an extra copy of the pre-final report and the executive summary be send to the U.S. Army Engineering District, Mobile, HQUSACE, and to the U.S. Army Logistic Evaluation Agency.

Address corrections for the following agencies are listed below:

- Commander
Fort McPherson
ATTN: AFZK-EH (Seabrook)
Fort McPherson, GA 30330

CONFIRMATION NOTICE

15 November 1991

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- Commander, FORSCOM
ATTN: FCEN-RDF (Kapur)
Fort McPherson, GA 30330-6000
- Commander
U.S. Army Engineering District, Savannah
ATTN: CESASPM-MP (Jenkins)
P.O. Box 889
Savannah, GA 31402

Mr. Lundstrom reviewed the EMC handout and discussed the field survey, analysis, and report preparation in detail. Mr. Lundstrom explained that several ECOs may be partially funded by Georgia Power Co. EMC will investigate this concept and include it in the ECO analysis. Mr. Lundstrom asked the following questions regarding the field survey:

- Q. What steps are necessary to survey secured buildings?
A. Mrs. Seabrook replied that Buildings 200 and 363 at Ft. McPherson and Building 101 at Ft. Gillem will require advance notice for an escort. Mr. Lundstrom will compile a building survey list schedule and coordinate with Mrs. Seabrook.
- Q. How is access obtained to secured building plans?
A. Mr. Kapur explained that FORSCOM does not allow secure building plans to be copied. However, the plans can be visually reviewed in order to investigate ECOs. Mr. Jenkins will also check the COE files in Savannah for secured building plans.
- Q. Is there a master mechanical room key?
A. Mrs. Seabrook will provide EMC with the necessary mechanical room keys, with the exception of the secured buildings; escort personnel will have keys for secured buildings.
- Q. Can DEH provide EMC with temporary car passes?
A. Yes.
- Q. Will EMC be provided with shop personnel's names and telephone numbers?
A. Mrs. Seabrook will introduce EMC to shop personnel prior to the survey.

Mrs. Seabrook requested a list of the people who will be performing the field survey. Mr. Lundstrom will provide Mrs. Seabrook with the list.

Ft. McPherson and Ft. Gillem will each receive separately bound reports.

Mrs. Seabrook requested that items be added to the building survey form (enclosed in the EMC handout). EMC will coordinate with Mrs. Seabrook.

CONFIRMATION NOTICE

15 November 1991

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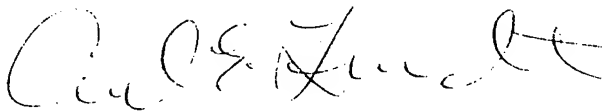
Mr. Kapur provided an example outline of the executive summary. Mr. Kapur also discussed the following items:

- EMC should contact PNL for information on demand side management.
- ECO cost estimates should include cross-reference information and labor and material costs.
- Each ECO should include ECO descriptions and sketches. ECOs which have no energy savings should be indicated.
- More emphasis was requested on ECOs regarding lighting. (Mrs. Seabrook has previously reviewed the interior lighting ECO.)
- Before the review meeting, there should be a site walk through the representative buildings included in proposed ECOs for the project.
- Exit signs should be counted during the building survey.
- A solar lighting project should be explored.

Mrs. Seabrook stated that the exterior lighting at Ft. McPherson is being maintained by Cleo. EMC will contact Cleo for exterior lighting information.

The following reports were provided to EMC:

- Feasibility Study for Lighting Shared Energy Saving Project at Ft. McPherson and Ft. Gillem, July 1990.
- RFP Paid from Shared Energy Saving Projects at Ft. McPherson and Satellite Installations, August 1991.



Carl Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 6

EMC #3105.000

DATE: 17 December 1991
TO/From: Earl Jenkins
Representing: U.S. Army Engineering District, Savannah

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

CONTRACT No.: DACA21-91-C-0097

NOTICE

PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

SUBJECT: Interim Submittal Date Change

The following is a summary of the items discussed, the comments made, and the decisions made during the telephone conversation:

This is to confirm a telephone conversation on 17 December 1991 between Earl Jenkins and Carl Lundstrom, in which Mr. Lundstrom requested a change in the schedule date for the Interim Submittal. The new schedule date was agreed to be 30 April 1992.

Carl Lundstrom

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 7

EMC #3105.000

DATE: 28 January 1992
To/From: Terry Seabrook

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem, GA

CONTRACT NO. DACA21-91-C-0097

NOTICE
PREPARED BY: Ron Gerrans
E M C Engineers, Inc.

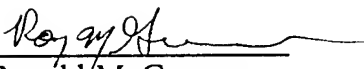
SUBJECT: Adjustment to Building Energy Conservation Opportunities (ECO) List

The following is a summary of the items discussed, the comments made, and the decisions made during the meeting on 28 January 1992 between Carl Lundstrom and Terry Seabrook regarding adjustments to the building ECO list. From this meeting the following changes to the building ECO list were recommended:

- Fort Gillem: EMC will drop the following buildings from the ECO list because the buildings are scheduled for demolition:
 - Fort Gillem: 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 918, 922, 923, 942
- EMC will create a new ECO. ECO 18 will be to convert existing incandescent exit signs to fluorescent. EMC will do this for the following buildings:
 - Fort McPherson: 041, 056, 058, 060, 062, 101, 170, 171, 181, 184, 200, 246, 363, 366, 400, 401
 - Fort Gillem: 101, 103, 207, 213, 400, 401, 512, 935
- For ECO 1, EMC will add Fort McPherson Bldg. 360
- For ECO 6, EMC will add Fort McPherson Bldg. 181
- For ECO 8, EMC will add the following buildings:
 - Fort McPherson Bldg. 363 and 400
 - Fort Gillem Bldg. 935
- For ECO 12, EMC will investigate special HVAC control applications on Fort McPherson Bldgs. 100, 131, 170, 171, 200

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28 January 1992
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- For ECO 13, EMC will add the following buildings:
 - Fort McPherson Bldgs. 060, 170, 171, 181, 184, 363, and 500
 - Fort Gillem Bldg. 101
- For ECO 15, EMC will add Fort McPherson Bldg. 200
- In addition, we will update the technical information from the Battelle and Stone & Webster lighting surveys to analyze the possibility of a Government ECIP project instead of the proposed shared energy savings project.


Ronald M. Gerrans

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 8

EMC #3105.000

DATE: 4 March 1992

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

CONTRACT No.: DACA21-91-C-0047

NOTICE Kamchornvuthi Chulavatr
PREPARED BY: E M C Engineers, Inc.

DATE OF
CONFERENCE: 19 February 1992

PLACE OF
CONFERENCE: DEH Conference Room, Building T-368
Ft. McPherson, Georgia

SUBJECT: Exit Interview

ATTENDEES: Earl Jenkins, Savannah District COE, (912) 944-5622, FAX 944-5442
Denise Williams, Savannah District COE, (912) 944-5530
Carl Lundstrom, E M C Engineers, Inc., (404) 952-3697
Kamchornvuthi Chulavatr, E M C Engineers, Inc., (404) 952-3697
Ron Gerrans, E M C Engineers, Inc., (404) 952-3697
Jim Mathis, DEH Ft. McPherson, (404) 752-2207
Naresh Kapur, HQ FORCOM, (404) 669-6731
Gene Reardon, Chief ERMD, (404) 952-4299
Barbara ZaKrzewski, DEH Housing, (404) 752-3381
Miles Wilson, JR., Deputy DEH, (404) 752-3258
LTC C.A. McNair, JR., DEH, (404) 752-2161

The following is a summary of the items discussed, the comments made, and the decisions made during the conference:

Mr. Lundstrom started the meeting by described the survey effort and pointing out probable areas of energy conservation identified during the survey.

Mr. Lundstrom described the project plan for work following the survey. Mr. Lundstrom then discussed the survey findings for each ECO in detail.

Mr. Chulavatr gave slide presentation of representative buildings.

Mr. Lundstrom solicited advice from DEH to resolve the following issues concerning ECOs to be evaluated:

- Window modification on historical buildings – the replacements can be double glass pane with wood frame and sash. The appearance of the new windows must be the same as the original windows.
- HVAC control – the HVAC control should be evaluated based on the life cycle cost analysis of the control system. The emphasis of the control system shall be based on the cost, maintenance, ease of operation, and energy conservation capability.
- Automatic light switch – Mr. Lundstrom proposed ideas for the automatic lighting control systems, which were included in the handout. The approaches were acceptable to DEH.
- Ventilation & recirculation – Mr. Lundstrom proposed an exhaust fan which can perform air stratification, recirculation, and exhaust, all in one unit. This unit will be evaluated for warehouses at Ft. Gillem. The approach was acceptable to DEH.
- Reduce street lights -- Mr. Lundstrom proposed to change this ECO to replace mercury vapor street lights with high pressure sodium street lights. The approach was acceptable to DEH.

Mr. Lundstrom proposed two additional ECOs for buildings at Ft. McPherson and Ft. Gillem. The two new ECOs are:

- ECO 18 – exit sign conversion
- ECO 19 – incorporate lighting studies done by other A/Es for shared savings

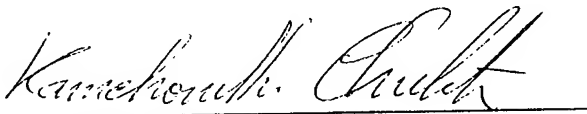
The DEH agreed for EMC to incorporate the two new ECOs in the study, as identified in the handout.

Confirmation Notice 8

4 March 1992

Page 3

Mr. Kapur asked EMC to include a section in the report to discuss other energy conservation project considerations. Mr. Wilson commented on the manpower savings of the 4-pipe fan coil over the 2-pipe fan coil system.



Kamchornvuthi Chulavatr

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 9

EMC #3105.000

DATE: 6 March 1992

PROJECT: Energy Savings Opportunity Survey for an EEAP
Ft. McPherson/Ft. Gillem

CONTRACT No.: DACA21-91-C-0047


NOTICE Jim Watters
PREPARED BY: E M C Engineers, Inc.

DATE: 6 March 1992

SUBJECT: Trace 600

ATTENDEES: Denise Williams, Savannah District COE, (912) 944-5530
Jim Watters, EMC Engineers Inc. (404) 952-3697

This is to confirm a telephone conversation on the 6th of March between Denise Williams, Savannah COE, and Jim Watters, EMC Engineers, regarding the use of the Trace 600 for this project. Ms. Williams approves the Trace 600 computer simulation program.



Jim Watters

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 10

EMC #3105-000

Date: 29 June 1992

PROJECT: Energy Savings Opportunity Survey for EEAP
Ft. McPherson/Ft. Gillem, GA
CONTRACT NO.: DACA 21-91-C-0097

NOTES
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 25 June 1992

PLACE OF
CONFERENCE: DEH Conference Room
Ft. McPherson, GA

SUBJECT: Presentation of Findings and Interim Report Review Comments

ATTENDEES: Terry Seabrook, Installation Energy Coord., DEH (404) 752-3076
Carl Lundstrom, E M C Engineers, Inc. (404) 952-3697
Chris Stanley, E M C Engineers, Inc. (404) 952-3697
Don Heldt, Foreman, OPS Branch, DEH OOH (404) 669-7163
Buddy Rappola, Maint. Mech. Superv., DEH FESD (404) 363-5411
John Rose, Gov't Sales, GA Power Co. (404) 526-3569
Dennis Lindemeier, Proj. Mgr., Savannah COE (912) 652-5623
Denise Williams, Mech. Engr., Savannah Dist. COE (912) 652-5530
Naresh Kapur, Mech. Engr., FORSCOM Engr. (404) 669-6731
Harry H. Foster, DEH O&M (404) 752-2686
Gwen Harvey, Dist. Rep.-Gillem, GA Power (404) 362-5449
Herb Joseph, Dist. Rep.-Gillem, GA Power (404) 362-5449
Jim Mathis, Ch., Engr, Plns & Svs Div., DEH (404) 752-2207

The following is a summary of the items discussed, the comments made, and the decisions made during the Conference:

1. Mr. Lindemeier introduced persons attending the meeting and gave the purpose for the review conference.
2. Mr. Lundstrom gave a presentation of the findings of the Interim Submittal, along with the recommendations to date.

3. General items discussed during a question and answer period include:

- Mr. Heldt: The motor readings taken in Building 200 need some description to inform the reader that a majority of the motors are variable speed and that the readings are taken at a part load. Mr. Lundstrom acknowledged this concern and agreed to add clarification.
- Mr. Kapur: Wanted to know if any exterior light readings were taken related to ECO 11. Mr. Lundstrom explained he remembers light readings were taken, and agreed to verify this and provide light readings for the report.
- Mr. Heldt and Ms. Seabrook: Would like to know more about the lighting control system for Building 200. There is concern about the number of telephone extensions and devices that would be required. Mr. Lundstrom agreed to provide additional catalog data for lighting control systems.

Interim submittal review comments were discussed. The following are the responses to review comments received from U.S. Army Corps of Engineers, Savannah District, and Ft. McPherson on the Interim Submittal.

REVIEWER: NARESH KAPUR, 4 JUNE 1992

<u>Item No.</u>	<u>Review Action</u>
1.	Thank you for the compliment.
2.	A, EMC tried to follow the format discussed. EMC will review descriptions and make improvements in format. Also see discussion in Confirmation Notice No. 2, item 8.
3.	A, EMC will look into the new Natural Gas rate structure and make any necessary corrections.
4.	A, EMC will look into the water and sewage rates and make any necessary corrections.
5.	D, the \$0.0255/kWh rate is based on low load factor, which is justified. No change.
6.	A, If the GA PSC decision is out by 7 July 1992, EMC will incorporate Demand Side Management credits into analysis of projects for final report.
7.	A, EMC will try to incorporate non-energy savings where feasible.
8.	A, EMC will reevaluate to take leakage into consideration.

9. A, This was not part of the Scope of Services. EMC will do a separate sample calculation for one building for Mr. Kapur directly. It is not intended to include this as part of the submittal.
10. A, Construction cost figures were obtained from 1992 "Means." Non-energy savings are very hard to quantify. EMC will reverify costs.
11. A, 0.0's will be replaced with blanks or NA.
12. A, EMC will discuss with DEH any projects they feel can be done in-house.

REVIEWER: WILLIAMS, 8 JUNE 1992

<u>Item No.</u>	<u>Review Action</u>
1.	A, Concur. Will correct.
2.	A, Concur. Will correct.
3.	A, Concur. Will correct.
4.	A, Concur. Will correct.
5.	A, Buildings were inadvertently left off list. Will correct.
6.	A, Building 100 was adequately insulated. Savings factors were calculated by removing insulation from Building 100 and resimulating.
7.	A, Concur. Will correct.
8.	A, Concur. Will correct.
9.	A, Concur. Will add.
10.	A, .8 gpm per 10 tons is a factor from the Table on page C-9.3 which is used to obtain a 65°F temperature rise. Will clarify.
11.	A, Btu figure is from computer simulation for Building 207. Will clarify.
12.	A, Concur. Will correct.
13.	A, Concur. Will correct.
14.	A, Concur. Will correct.

15. A, The increase is actually a savings. Wording will be changed to clarify.
16. A, Concur. Will correct.
17. A, See Item No. 10.
18. A, Calculations are contained within spreadsheet. This is just a sample calculation. Will clarify calculation as per Item No. 11.
19. A, We will attach references. The spreadsheet calculations follow the format of the energy consumption calculations on Pages C-14.2.5 - C-14.2.8.

REVIEWER: TWITTY, 15 JUNE 1992

<u>Item No.</u>	<u>Review Action</u>
-----------------	----------------------

- | | |
|----|---|
| 1. | A, The correct construction cost is \$172,912. There was a wrong number in the table that will be corrected. No change in payback. |
| 2. | A, This cost is due to the size of the building and the complexity of the control system. We will look further into the control system and connections to the existing EMCS system. The occupancy sensors described on pages 3-63 and 3-64 are designed to replace existing light switches. |

REVIEWER: JOSEPH, 25 JUNE 1992

<u>Item No.</u>	<u>Review Action</u>
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Regarding Table 3-26, on page 3-67

D, The correct reference is page 3-76. The columns are correct. No change.

REVIEWER: SEABROOK

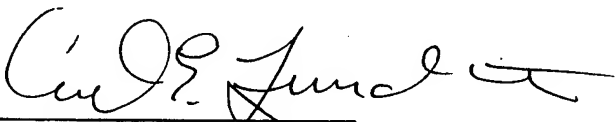
<u>Item No.</u>	<u>Review Action</u>
-----------------	----------------------

- | | |
|----|-----------------------------------|
| 1. | A, Will add legend to all pages. |
| 2. | A, Will correct building numbers. |
| 3. | A, Will correct. |

4. A, Will revise.
5. A, Will add LCCA summary.
6. D, Defer comment to Savannah District. Mr. Lindemeier will prepare milestone dates for completion of the project.
7. A, Will add.

REVIEWER: HELDT/FOSTER

8. A, Will correct table.
9. A, Will clarify.
10. A, Will review, correct, and clarify.
11. A, Will review, correct, and clarify.
12. A, Will correct recommendations.
13. A, Will correct errors in Table.
14. A, Will add clarification.
15. A, Will correct figure.
16. A, Will add heading to columns.
- GEN. A, Will correct Table of Contents for Appendices.



Carl E. Lundstrom, P.E.
Project Manager

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

CONFIRMATION NOTICE

Confirmation No. 11

EMC #3105-000

Date: 29 June 1992

PROJECT: Energy Savings Opportunity Survey for EEAP
Ft. McPherson/Ft. Gillem, GA

CONTRACT NO.: DACA 21-91-C-0097

NOTES
PREPARED BY: Carl E. Lundstrom
E M C Engineers, Inc.

DATE OF
CONFERENCE: 2 July 1992

PLACE OF
CONFERENCE: DEH Conference Room
Ft. McPherson, GA

SUBJECT: To Identify Non-appropriated Fund Facilities

This is to confirm a meeting with Terry Seabrook and Tom Baldwin of the Ft. McPherson Directorate of Engineering and Housing, and Carl Lundstrom of EMC Engineers, Inc. The following is a summary of the items discussed, the comments made, and the decisions made.

1. The following buildings are not to be included in energy projects developed for ECIP funding, because they are NAF facilities which pay for their own utilities:

Ft. McPherson:

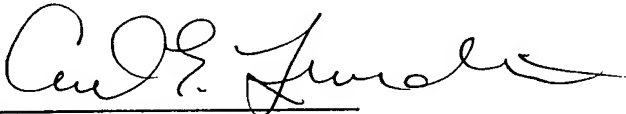
- Bldg 155, NCO Club
- Bldg 360, Commissary
- Bldg 500, Dining Facility

Ft. Gillem:

- Bldg 133, Community Center, Club
- Bldg 214, Commissary
- Bldg 505 through 514, Warehouses (AAFES)

2. Mr. Baldwin explained the following buildings at Ft. McPherson will be torn down shortly to accommodate the construction of a new medical facility. These buildings should not be included in energy projects development:

- 116, Administration
- 117, Classroom
- 118, Administration
- 120, Administration
- 121, Administration
- 122, Administration
- 124, Administration
- 126, Administration



Carl E. Lundstrom, P.E.
Project Manager

If any portion of this confirmation notice is incorrect, please notify us immediately. If correspondence is not received to the contrary within 14 days, it will be assumed that the decisions and conclusions, and status outlined in this confirmation notice are correct.

Project Review Comments: Energy Savings Opportunity Survey
(ESOS) Forts McPherson/Gillem

Reviewed by: SEABROOK

<u>Item No.</u>	<u>Paragraph No.</u>	<u>Comments</u>	<u>ACTION</u>
1	Pg E-5 Ft Mac	Table E5.3 - Building ECO Matrix shall include legend on all pages.	A - Added legend to all pages of table.
2	Pg 3-49 Ft Mac	Correct building number in Field survey listing.	A - corrected building no's
3	Pg 3-3 Ft Mac	Add ECO 10 & 17 to Table 3.2 (Nonfeasible ECOs)	A - Added ECO's to table 3.2.
4	Pg 3-55 ECO 12 Ft Mac	Bldgs 131, 168, 170 & 171 Revise or Repair HVAC Controls - These buildings do not have boilers. They use steam.	A - Changed reference from boiler to converter, and corrected numbers.
5	Appendix C-7 Ft Mac	Where is the Life Cycle Cost Analysis.	A - Added LCCA Sheet for ECO 7
6	E1 Both Forts	List Milestone Dates as Real/Actual Dates	A - Added dates from letter received from cont. officer.
7	Gen	Life Cost Analysis Summary Investment - Where is 1F and 3B. ↓ 1E	30 June 1992 A - Changed 1F to 1E on sheets. 3B is not used. This is a gov't provided program.
Heldt/Foster			
8	Pg 3-11 Ft Mac	Occupancy for Bldg. 200 is in error.	A - Corrected schedule on page 3-11.
9	Pg 3-49 Ft Mac	Error in building. Please clarify.	A - Added clarification.

Project Review Comments: Energy Savings Opportunity Survey
(ESOS) Forts McPherson/Gillem

<u>Item No.</u>	<u>Paragraph No.</u>	<u>Comments</u>	<u>ACTION</u>
Heldt/Foster			
10	Pg 3-56 Ft Mac	EMCS is already staging units off line during unoccupied periods.	A - Additional clarification provided.
11	Pg 3-59 Ft Mac	Do not understand entry for Bldg. 200. Explain.	WD
12	Pg 3-60 Ft Mac	"Recommendations" - ?	A - Recommendations provided.
13	Pg C5.5 C5.6 C5.11/C5.12	Many errors in readings and specs. Subject to question. Use of variable frequency drives not discusse. Explain.	A - Errors corrected. Economy of variable speed drives provided.
14	Pg C12.16 Ft Mac	Do not understand at all Explain.	A - Additional clarification provided.
15	Pg C13.3 Ft Mac	Schematic not correct.	A - Schematic corrected.
16	Pg C15.1.6 Ft Mac	Explain calculations.	A - Calculations clarified.
SEABROOK	Gen	Volume II Appendix E conflicts the Table of Contents. See Appendix F.	A - Corrected Table of Contents.

5 JUNE 92

FCEN-RDF

MEMORANDUM FOR COMMANDER, US ARMY ENGINEERING DISTRICT,
SAVANNAH, ATTN: CESAS-PM-MP/MR. EARL JENKINS,
100 W. OGLETHORPE AVENUE, SAVANNAH, GA 31402

SUBJECT: Energy Saving Opportunity Survey for an EEAP, Fort
McPherson/Gillem, GA

1. We received two copies of Volume I, Interim Submittal, Executive Summary, Appendices A-D of the subject energy study from EMC Engineers Inc. Our review comments are enclosed. We are very impressed with EMC Engineers efforts and responsive attitude despite difficulties involved in conducting an EEAP study.

2. Please let us know when a meeting to discuss the review comments and EMC Engineers' response is scheduled. Mr. Kapur, COMM 404-669-6731, can provide you additional information on the subject matter.

FOR THE ENGINEER:

Encl

RONALD D. BENTSEN
Chief, Resources Division

MFR: Due to other commitments, we are a little behind on providing review comments to Savannah Dist.

RELEASED BY _____
Kapur/6731/cm/5 Jun 92/ECIPCMTM Stoudenmire Date

Bentsen Date

6/5/92 Earl Jenkins 912-652 5822, FAX
1350 Told him that will mail the review
comments ASAP. If he is in a bind
let us know, we can FAX the
Cmts to him. He said - no big
hurry.

FORSCOM ECIP REVIEW COMMENTS DATE: 6/4/92 PG 1/2

PROJECT: ENERGY SAVING OPPORTUNITY SURVEY, FT MCPHERSON/GILLEM

REVIEWER: NARESH KAPUR, PE, FCEN-RDF, TEL: 404-669-6731/FAX-7751

ITEM NO.	PARA# PAGE#	COMMENT	REVIEW ACTION
1.	Gen	The following comments are related to Ft McPherson but the same comments should be considered for Ft Gillem as applicable. AE HAS DONE ACCOMMENDABLE JOB.	NO Action Req'd
2.	Gen	ECO description should briefly discuss the current situation, situation after completion of ECO and method of accom plishment. We encourage sketches, and catalog type info wherever practical.	A - Added current situation descpt.
3.	2.2.2 2-2	Look into the current Natural Gas rate structure effective recently. Gas rates consist of six parts as follows: Monthly customer charge; Firm use charge; Consumption charge; Firm purchase gas adjustment; Interruptible purchase gas adjustment; Other misc. charges (Franchise recovery and take or pay). The current monthly customer charges are \$800 for McPherson and \$1,000 for Gillem. Firm use charges are \$10,400 for Gillem. Consumption Charges are \$0.07/therm for 1st 100,000 therms. For next 200,000 therms, \$0.057/therm. Gas adjustment charge of \$0.397/therm is for firm supply and charges for interruptible supply is much less.	A - Obtained new rates from AGL. Used revised rates.
4.	2.2.3 2-3	Water and sewage rates are different for McPherson and Gillem.	A - Revised rates.
5.	2.5.2 2-9	Average energy charge used is 0.0255/Kwh. Does it assume all energy reduction in high load factor block? Can this be justified?	W.D.
6.	2.6 2-10	Latest Info. GA PSC decision due 7/7/92.	A - GA PSC decision on 7/7/92 had no info related to this study. No change.
7.	3.4	ECO Analysis. Consider non-energy savings wherever possible. Example: New surface provided by wall insulation may need less maintenance and upkeep for some time.	A - Labor savings added to ECO 12 see App C and D.

FORSCOM ECIP REVIEW COMMENTS DATE: 6/4/92 PG 2/2

PROJECT: ENERGY SAVING OPPORTUNITY SURVEY, FT MCPHERSON/GILLEM

REVIEWER: NARESH KAPUR, PE, FCEN-RDF, TEL: :404-669-6731,
FAX-7751

<u>ITEM</u> <u>NO.</u>	<u>PARA#</u> <u>PAGE#</u>	<u>COMMENT</u>	<u>REVIEW</u> <u>ACTION</u>
8.	3.4.1 3-17	In the ECO, do we recognize leakage of conditioned air as a source of energy waste? If so, AE should consider fixing leakage as part of the ECO.	A - Added leakage to insulation calculations
9.	3.4.2 3-23	Consider Window Quilts for insulation and comfort. Addl info available with Mr. Kapur. Fort Drum used it recently.	A - An example calculation for window quilts was provided sep. from report/study.
10	3.4.3 3-30	Weatherstripping and caulking. PB is high. AE is requested to recheck const cost figures and possible non-energy savings due lower annual maintenance cost. In the current guidance, 100% nonenergy savings are allowed in Economic analysis. Mr Kapur has the info.	A - Costs were checked against cost estimate guides. Further clarification was added to the report.
11.	4.1 4-3	In different tables, SIR or PB value of 0.0 is misleading. AE may consider leaving it blank or using NA etc.	A - Tables were revised to show blanks.
12.	Gen	Wherever PB of an ECO is more than 8 years, AE is requested to check if inhouse accomplishment can provide desirable payback.	A - McPherson does not feel it has adequate staffing to accomplish ECOs except as noted for low cost/ no cost ECOs

PROJECT COMMENTS		Date: 8 Jun 1992 Page 1 of 2
Project: Energy Savings Opp. Survey		To: EMC Engineers Inc.
Site(s): Ft. McPherson, GA		Thru: PM-MP/Lindemeier
FY: 1992		Thru: EN-D/Lupton
LI: 2006000		Thru: EN-DF/Hughes
CN:		From: EN-DF/Williams

<input type="checkbox"/> Foundation Report	<input type="checkbox"/> Preliminary Submittal	<input type="checkbox"/> Annotated Comments
<input type="checkbox"/> 10% Submittal	<input type="checkbox"/> Pre-Final Submittal	<input type="checkbox"/> Customer Comments
<input type="checkbox"/> Concept Submittal	<input type="checkbox"/> Final Submittal	<input type="checkbox"/> Correspondence
<input checked="" type="checkbox"/> Interim Submittal	<input type="checkbox"/> VE Study	<input type="checkbox"/> Corrected Final

Item	Refer	Comment	Action
1.	General	The payback should be as shown on the LCCA sheet. The payback shown on the summary tables is different. Volume I of Ft. McPherson study	A - Paybacks corrected.
2.	pg ES-2	Indicate that ECO 4 is only to record water temperatures and does not involve calculations.	A - Note added to Table to indicate measurement only.
3.	pg ES-4	Add ECO 17 to the list of non-feasible ECOs.	A - Added ECO to Table.
4.		Tables ES.2 and ES.3 do not agree. Some ECOs that are shown as not applicable on Table ES.3 are not listed in Table ES.2 (ECO 5 for example). Also ECO 1 is shown as not applicable for some buildings but some parts of ECO 1 (pipe insul.) was applicable.	A - Made corrections to Tables to fix differences in ECOs 1 and 5
5.	pg 3-11	Buildings 40-42 were not simulated. Are they similar to some other buildings? How was the energy savings determined?	A - Clarification added.
6.	pg 3-15	This table shows energy savings for ECO 1 (wall and roof) for buildings 111-126 but the simulation for building 100 which is typical for these buildings does not show any savings.	A - Clarification added to computer simulation summaries Appendix C-20.
7.	pg 3-22	Bldg 114 has a SIR of 0.6 and should not be included.	A - Table corrected.
8.	pg C-5.1	ECO-5 should be evaluated based on 25 years.	A - LCCA corrected.
9.	pg C-7.2	The LCCA sheet was not included.	A - LCCA added for ECO.
10.	pg C-9.2	Document in your assumptions the 0.8 gpm figure used in calculating the pump size.	A - Clarification added.
11.	pg C-10.2	The calculations for ECO 10 is not clear. How was the 5,960,000 Btuh figure derived. I did not see a computer simulation for this building. Please clarify this ECO and clearly state all assumptions made. Volume I of Ft. Gillem study	A - Sample calculation added. 5,960,000 Btuh figure deleted from calc.
12.	pg ES-2	Same as comment #2.	A - Note added Table to indicate measurement only.
13.	pg ES-3	Add ECO 5 to buildings 401 and 403 and explain why they are not feasible.	A - ECO 5 added to Table for 401 & 403 with explanation.

PROJECT COMMENTS		Date: 8 Jun 1992	Page 2 of 2
Project: Energy Savings Opp. Survey Site(s): Ft. McPherson, GA		To: EMC Engineers Inc. From: EN-DE/Williams	
<div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> Foundation Report <input type="checkbox"/> 10% Submittal <input type="checkbox"/> Concept Submittal <input checked="" type="checkbox"/> Interim Submittal </div> <div> <input type="checkbox"/> Preliminary Submittal <input type="checkbox"/> Pre-Final Submittal <input type="checkbox"/> Final Submittal <input type="checkbox"/> VE Study </div> <div> <input type="checkbox"/> Annotated Comments <input type="checkbox"/> Customer Comments <input type="checkbox"/> Correspondence <input type="checkbox"/> Corrected Final </div> </div>			
Item	Refer	Comment	Action
14.	pg 3-8	This narrative does not show the buildings that were analyzed at Gillem.	A - Corrected narrative.
15.	pg 3-71	This page indicates no energy savings but the following page indicates saving. Please clarify.	A - Clarification provided.
16.	pg C-5.1	ECO-5 should be evaluated based on 25 years.	A - Revised LCCA for 25 years.
17.	pg C-9.2	Document in your assumptions the 0.8 gpm figure used in calculating the pump size.	A - Clarification added.
18.	pg C-10.2	Where are the calcs for buildings on page C-10.1? This calculation is for a building at McPherson. Please clarify this ECO and clearly state all assumptions made.	A - Sample calculation corrected. Calculation is for a building at Gillem.
19.	pg C-14.5	What are references 4, 5, 6, & 8 mentioned on this page? Where is the sample calculation for this ECO?	A - References provided. Sample calculation added.

PROJECT COMMENTS		Date: 15 June 1992 Page 1 of 1													
Project: Energy Savings Opp. Survey Site(s): Ft. McPherson, GA FY: 1992 LI: 2006000 CN:		To: EKC Engineers Inc. Thru: PH-MP/Lindemeier Thru: EN-D/Lupton Thru: EH-DE/Hughes From: EN-DE/TWitty													
<table style="width: 100%; border: none;"> <tr> <td style="width: 33%; border: none;"><input type="checkbox"/> Foundation Report</td> <td style="width: 33%; border: none;"><input type="checkbox"/> Preliminary Submittal</td> <td style="width: 33%; border: none;"><input type="checkbox"/> Annotated Comments</td> </tr> <tr> <td style="border: none;"><input type="checkbox"/> 10% Submittal</td> <td style="border: none;"><input type="checkbox"/> Pre-Final Submittal</td> <td style="border: none;"><input type="checkbox"/> Customer Comments</td> </tr> <tr> <td style="border: none;"><input type="checkbox"/> Concept Submittal</td> <td style="border: none;"><input type="checkbox"/> Final Submittal</td> <td style="border: none;"><input type="checkbox"/> Correspondence</td> </tr> <tr> <td style="border: none;"><input checked="" type="checkbox"/> Interim Submittal</td> <td style="border: none;"><input type="checkbox"/> YE Study</td> <td style="border: none;"><input type="checkbox"/> Corrected Final</td> </tr> </table>				<input type="checkbox"/> Foundation Report	<input type="checkbox"/> Preliminary Submittal	<input type="checkbox"/> Annotated Comments	<input type="checkbox"/> 10% Submittal	<input type="checkbox"/> Pre-Final Submittal	<input type="checkbox"/> Customer Comments	<input type="checkbox"/> Concept Submittal	<input type="checkbox"/> Final Submittal	<input type="checkbox"/> Correspondence	<input checked="" type="checkbox"/> Interim Submittal	<input type="checkbox"/> YE Study	<input type="checkbox"/> Corrected Final
<input type="checkbox"/> Foundation Report	<input type="checkbox"/> Preliminary Submittal	<input type="checkbox"/> Annotated Comments													
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<input type="checkbox"/> Concept Submittal	<input type="checkbox"/> Final Submittal	<input type="checkbox"/> Correspondence													
<input checked="" type="checkbox"/> Interim Submittal	<input type="checkbox"/> YE Study	<input type="checkbox"/> Corrected Final													
Item	Refer	Comment	Action												
		Volume I of Ft. McPherson study													
1.	pg 3-36	The total construction cost shown is \$172,912. The correct figure should be 162,913. This will change the payback.	A - Revised motor savings and costs. from the manufacturer.												
2.	pg 3-69	\$220,706 is a lot of money for lighting controls for one building. Is it possible to tie the lighting controls in this building into the existing building BDC system or use occupancy sensors as described on pages 3-63 and 3-64?	A - Revised costs obtained from manufacturer.												



Georgia Power

the southern electric system

June 25, 1992

Ms. Terry R. Seabrook
Department of Army
HQ Fort McPherson
DEH Bldg. 358
Fort McPherson, GA 30330-5000

RE: Energy Savings Opportunity Survey

Dear Ms. Seabrook:

I have reviewed the above referenced material as requested. It is a very thorough report and appears to be technically sound. I would like to examine some of the detailed calculations as time did not permit me to do so.

Below are notes of interest for your review:

- °Demand savings may not be realized until
billing demand ratchets run their course. INFO ONLY
- °All demands on equipment may not be
coincident and therefore savings may not be
a combination of selected ECO projects. INFO ONLY
- °Table 3-26 on page 3-67 has "Billing and
Actual Demands" reversed. 3 ^{A-76} / PAGE 3-76
THE SAME, NO
CHANGE.

As we discussed earlier, opportunity exists to control demand and, to a lesser degree, energy with demand control computerized equipment. We also can look at different rate applications that may benefit Fort Gillem. I have also enclosed a copy of the energy efficiency programs offered by Georgia Power.

If you have questions, please do not hesitate to call me or Gwen Harvey at 362-5546. I look forward to discussing this information on the morning of June 25.

Sincerely,

Herbert Joseph

CONFERENCE PARTICIPANTS

PROJECT:

ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)

CONTRACT NUMBER:

DACA 21-91-C-0097

LOCATION:

Ft. McPHERSON.

RE-FINAL REV. CONF. ; 21 AUGUST 1992

NAME

POSITION

OFFICE SYMBOL

TELEPHONE

DEANIS H.

PROJECT

COE, SAVANNAH

(912) 652-5623

LUNDSTROM

MANAGER

CEASAS-MANIP

DSN 971-6330 ext. 5623

TERRY R. SEABROOK

INSTALLATION

AFZK-EHE

(404) 752-3076

ENERGY CODE

AUTOVON 572-3016

CARL LUNDSTROM PM

EMC ENGINEERS, INC (404) 952-3697

BUDDY RAPPOLD

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MECH. SUPP.

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NARESH KAPUR

MECH ENGR

HQ FORSCOM
FCEN-RDE

404-669-6731

HC. CAM

KAPUR

Ft. McPHERSON

742-2161

ATTACHMENT 1

FORSCOM EGAP REVIEW CMTS 8/7/92.

PROJECT: ESOS FORT McPHERSON/ GILLEM. GA.

REVIEWER: NARESH KAPUR. PE, 404-669-6731

Notes: Comments are for Ft McPherson study. Also applicable to same ECos at Gillem. FAX X 7751

ITEM#	PARA PAGE	COMMENT	REVIEW ACTION
-------	-----------	---------	---------------

1. **GENERAL** During 25 June 92 mtg, A/E ^{DOT 301} ~~NO FURTHER~~ agreed to provide Light level readings **ACTION REQUIRED**
 App. C.; C 11.4 → C 11.8
 Where do we look for info.

2. **ES-4** Consider overall cumulative numbers
 Don't ~~ES-10~~ ^{ES-10} for Const Cost, Annual savings, Annual cost avoidance, PB, SIR. This Table is repeated.

3. **General** Write a 1 or 2 Page wrap up letter to Garrison Cdr explaining in layman's terms items like ECOS, recommended Total Cost, Total savings, Pay Back/ Return on investment etc. What are the suggested priorities/sequence of accomplishing them. Which ones should be done 1/H. This is not for the report but for presentation purpose.

4. **3.4.1.2** PI explain the calculations, especially as associated with fixing the leakage as part of this ECO. Cost Increase ^(P2543) in the enclosed Table needs to be explained.

PROVIDE SOME ADDITIONAL ECO DESCRIPTION TO CHAPTER 3
 THESE INCREASES WERE THE RESULT OF FACTORING IN CONTINGENCIES & DESIGN (APPROX 11%)
 ATTACHED #2

FORSLOM REAP REVIEW CMT
ESOS FORT MCPHERSON/GILLEM GA
FORSLOM Supr. Mr Kapur 404-669-8731

ITEM#	PARA PAGE	COMMENT	REVIEW ACTION
-------	--------------	---------	------------------

5. 3.4.5
3-33

PB 13.2 . Can you calculate PB based on differential cost basis only . Change recommendations accordingly . Does the Eco consider if the Motors are Variable speed or hours of operation ?

A

6. 3.4.11
3-52

Is there difference in life (hrs) of different light bulbs . Would that result in Non-energy saving (±) .

A

7.

CHECK CALCULATION METHODOLOGY (LEAKAGE) TO BE CERTAIN LEAKAGE GOES DOWN (AS CLOSE TO ZERO AS POSSIBLE) .

A

TABLE 3-10
ECO 1, DUCT INSULATION

Interior

Bldg	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
042	0	5,620	52	71	386	0	0	386	1,584	4.5	4.1
116	0	7,804	72	99	537	0	0	537	2,202	4.5	4.1
105	0	301	3	4	21	0	0	21	86	4.5	4.1
358	0	7,008	64	88	480	0	0	480	1,975	4.5	4.1

Old

1

12

19.1

TABLE 3-10
ECO 2, DUCT INSULATION

Prefinal

Bldg	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Annual Gas Savings (MBtu/yr)	Total Energy Savings (MBtu/yr)	Annual Energy Savings (\$/yr)	Annual Demand Savings (\$/yr)	Annual Non-Energy Savings (\$/yr)	Total Annual Savings (\$/yr)	Const. Cost (\$)	SIR	Simple Payback (yrs)
105	0	469	4	5	29	0	0	29	104	5.7	3.6
116	0	10,385	86	121	665	0	0	665	2,700	5.1	4.1
358	0	9,412	77	110	602	0	0	602	2,426	5.1	4.0
042	0	7,408	61	87	475	0	0	475	1,945	5.0	4.1
118	0	1,982	15	12	122	0	0	122	2,449	1.0	20.1

New

New

S: 3 Aug 92/Monday

PROJECT REVIEW COMMENTS		Date: 29 July 1992	Page of
TO: SEABROOK		FROM: (Section) O & M (Reviewer) HELDT	
Project: Energy Savings Opportunity Survey		Year: FY-92	Line Item No.:
Location: Fort McPherson, GA.			
Type of Action: <input type="checkbox"/> Preliminary <input type="checkbox"/> Paving & Grading <input type="checkbox"/> Mechanical (Check appropriate <input type="checkbox"/> Final <input type="checkbox"/> Architectural <input type="checkbox"/> Electrical boxes) <input type="checkbox"/> Structural <input type="checkbox"/> Sanitary			
Item No.	Drawing No. or Par. No.	COMMENTS	REVIEW ACTION*
1	Appendix B, Interim Submittal Pg 2 of 8	Item # 13 - Errors Have <u>Not</u> Been Corrected • VOLTAGES WILL BE CORRECTED. • EFFICIENCIES OF VARIABLE SPEED MOTORS WILL ALSO BE ADDRESSSED W/ GREATER DETAIL	X

Project: Energy Savings Opp. Survey To: EMC Engineers Inc.
 Site(s): Ft. McPherson, GA Thru: PM-MP/Lindemeier
 FY: 1992 Thru: EN-D/Lupton
 LI: 2006000 Thru: EN-DF/Hughes
 CN: From: EN-DF/Williams

☐ Foundation Report ☐ Preliminary Submittal ☐ Annotated Comments
☐ 10% Submittal ☒ Pre-Final Submittal ☐ Customer Comments
☐ Concept Submittal ☐ Final Submittal ☐ Correspondence
☐ Interim Submittal ☐ VE Study ☐ Corrected Final

Item	Refer	Comment	Action
		Ft. Gillem Study	
1.	pg C.14.2.1A	This page indicates that the energy savings were from a simulation for Bldg 207. Where is the sample calculation using the equations on page C.14.2.3? How were the factors BLC and G, shown on page C.14.2.3 derived?	NO SUBMITTAL, SAMPLES A
2.	pg ES-2	Add measurement only to ECO 4 of the separately bound Executive Summary and Volume 1.	A
3.	pg 4-1	Why wasn't ECO-1, Roof Insulation included in any of the projects. THERE IS AN ECO FOR BLDG 207 & THIS WILL BE INCH. W/ AS AN MCA PROJECT.	A

CALCULATION WAS USED.

TEXT WILL BE REVISED TO IMPROVE CLARITY.

APPENDIX B

UTILITY RATES AND HISTORICAL USAGE CALCULATIONS

GEORGIA POWER COMPANY

Full Use Service to Governmental Institutions

SCHEDULE "G-10"

AVAILABILITY:

Throughout the Company's service area from existing lines of adequate capacity, except that service under this tariff is not available to a customer who is served from an underground network system or who applies for service after December 29, 1981 at a service level below 12 kV.

APPLICABILITY:

Full use service to large Federal, State, and Municipal agencies and Institutions at a single delivery point through a single meter. This schedule is not applicable to Housing Projects or other Governmental agencies or Institutions whose service requirements are predominantly residential, nor is it available to any customer who has more than one meter per structure.

TYPE OF SERVICE:

Single or three phase, 60 hertz, at a standard voltage.

MONTHLY RATE - Energy Charge Including Demand Charge:

Base Charge \$55.00

All consumption (kWh) not greater than
300 hours times the billing demand:

First 50,000 kWh	@	6.00¢ per kWh
Next 150,000 kWh	@	5.82¢ per kWh
Next 800,000 kWh	@	4.42¢ per kWh
Over 1,000,000 kWh	@	4.10¢ per kWh

All consumption (kWh) in excess
of 300 hours times the billing
demand..... @

1.15¢ per kWh

Minimum Monthly Bill:

\$55.00 Base Charge plus \$8.00 per kW of Billing Demand, but not less than \$3,400.00 per month, plus excess kVAR charges and Fuel Cost Recovery as applied to the current month kWh.

FUEL COST RECOVERY:

The amount calculated at the above rate will be increased under the provisions of the Company's effective Fuel Cost Recovery Schedule, including any applicable adjustments.

DETERMINATION OF BILLING DEMAND:

The Billing Demand shall be based on the highest 30-minute kW measurement during the current month and the preceding eleven (11) months.

For the billing months of **June through September**, the Billing Demand shall be the greatest of:

- (1) The current actual demand, or,
- (2) Ninety-Five percent (95%) of the highest actual demand occurring in any previous applicable summer month (June through September), or,
- (3) Sixty percent (60%) of the highest actual demand occurring in any previous applicable winter month (October through May).

For the billing months of **October** through **May**, the Billing Demand shall be the greater of:

- (1) Ninety-Five percent (95%) of the highest summer month (June through September), or,
- (2) Sixty percent (60%) of the highest winter month (October through May), including the current month.

In no case shall the Billing Demand be less than the greatest of:

- (1) The contract minimum, or,
- (2) Fifty percent (50%) of the total contract capacity, or,
- (3) 3,000 kW for any customer applying for service under this rate subsequent to December 22, 1971, or,
- (4) 6,000 kW for any customer applying for service under this rate subsequent to December 29, 1981.

Where there is an indication of a power factor of less than 95% lagging, the Company may, at its option, install metering equipment to measure Reactive Demand. The Reactive Demand shall be the highest 30-minute kVAR measured during the month. The Excess Reactive Demand shall be kVAR which is in excess of one-third of the measured actual kW in the current month. The Company will bill excess kVAR at the rate of \$0.27 per excess kVAR.

TERM OF CONTRACT:

Not less than one year.

REVENUE ADJUSTMENT:

The bill calculated at the above rate is subject to change in such an amount as may be determined under the provisions of the Company's Revenue Adjustment Rider, Schedule "RA-1", as approved by the Georgia Public Service Commission or as may be later amended.

Service hereunder subject to Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Territory:

In the natural gas service areas of the Company as shown on the current Rate Zone Map on file with the Georgia Public Service Commission.

Available:

On Special Contract to any regular natural gas customer on an interruptible basis for commercial purposes whose normal productive uses of gas require a consumption of 1,000 therms or more of gas in any one day in the territory shown above, and who contracts in writing for service under this schedule for substantially all of his fuel requirements that the Company can supply, provided the Company has gas delivery capacity in excess of the then existing requirements of other customers and provided the Company has available to it from its suppliers at the delivery point nearest to the customer an adequate supply of natural gas to meet the customer's requirements. The Company reserves the right to refuse (a) to contract for Firm Use Gas, or (b) to make gas available where the relationship between the average daily consumption and the maximum daily consumption indicates a forced or unusual usage on the maximum day in an attempt to qualify for the minimum daily consumption stated above.

Character of Service:

1. All gas delivered under this rate schedule shall be subject to curtailment in whole or in part only after the Company has given at least thirty minutes notice by telephone or otherwise except in force majeure conditions. The Company may curtail customers served under this rate schedule in such order and each customer to such extent as the Company deems necessary for the proper operation of its distribution systems. Upon notice of curtailment by the Company in whole or in part of the supply of gas to the customer, the customer must promptly discontinue use of gas in whole or in part as provided in the curtailment notice.
2. Interruptible service may be curtailed at any time after notice as provided in (1) above.
3. Firm Use gas as hereinafter defined will not be curtailed except pursuant to the Company's load control provisions filed with and approved by the Georgia Public Service Commission from time to time.

Effective:

With service on and after
February 1, 1992

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Rate:

Customer Charge:

The monthly customer charge shall be based upon the maximum use occurring in the current month or the prior eleven months as follows:

<u>Maximum monthly use</u>	<u>Monthly Charge</u>
Under 30,000 therms	\$ 300
30,000 to 49,999 therms	375
50,000 to 99,999 therms	475
100,000 to 249,999 therms	800
250,000 to 499,999 therms	1,000
500,000 to 999,999 therms	2,000
1,000,000 to 2,999,999 therms	4,500
3,000,000 to 7,500,000 therms	11,000
Over 7,500,000 therms	18,000

Firm Use Charge:

For the quantity of natural gas stated in the contract for service as the Firm Use per day at \$15.60 per therm per year billed at \$1.30 per therm per month.

Commodity Charge:

	<u>Monthly Rate Per Therm Net</u>
First 100,000 therms used per month	7.0 cents
Next 200,000 therms used per month	5.7 cents
Over 300,000 therms used per month	4.7 cents

Summer Air-Conditioning Rate:

For any customer who qualifies for service under this rate schedule who has installed and regularly operates a gas-fired central air conditioning system which meets Company's specifications and which equipment consumes more than 50% of the total gas used during the seven-month period April through October inclusive, all gas used during such period, in excess of 4,000 therms per month, will be billed at 3.5 cents per therm.

Firm Use:

Firm Use is the daily rate of taking of gas in therms agreed upon in writing as the maximum rate of delivery which the Company shall be required to make to the customer in any one

Effective:

With service on and after
February 1, 1992

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Firm Use (cont'd)

day during any period when the Company's supply of natural gas, in the opinion of the Company, is inadequate to supply the total requirements of all its customers supplied from the delivery point from which the customer is supplied. The hourly rate of delivery of Firm Use Gas shall not be greater than 1/18th of the Firm Use per day contracted for. Except in cases of force majeure as defined herein, in the Company fails to deliver for a period of more than 24 continuous hours in any month the amount of the daily firm quantity contracted for, the firm use charge for that month shall be prorated on a daily basis.

Unauthorized Consumption of Gas:

In the event the customer fails to comply with any curtailment order of the Company reducing either the customer's hourly or daily use of gas, the Company may elect one of the following options:

- (A) To discontinue completely all deliveries to the customer, including any Firm Gas under contract, during the day customer fails to comply with such curtailment order; or
- (B) To furnish such quantity of overrun gas as the Company, in its judgment determines it can supply, at a surcharge of 50.0 cents per therm in addition to the regular commodity charge for such gas, subject however to discontinuance at any time by the Company at its election.
- (C) To require Customer to pay Company a charge of \$3.00 per therm for all unauthorized gas taken, not supplied by Company pursuant to (B) above, in addition to the regular commodity charge for such gas.

Determination of Therms:

The gas for any billing period, expressed in hundreds of cubic feet shall be multiplied by the average BTU of the gas send-out as determined below and divided by 1,000 in order to determine the number of therms consumed for billing purposes. Such calculation shall be made to the nearest whole therm.

Effective:

With service on and after
February 1, 1992

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Determination of Therms (cont'd)

The average BTU of the gas send-out for billing purposes shall be calculated for each calendar month from the weighted average BTU of natural gas delivered to the Company in the city or area where the customer receives service by the Company's suppliers and from the gas delivered by the Company in such city or area from its standby plants, as determined by appropriate calorimeters operated by the Company or its suppliers.

Minimum Monthly Bill For Firm Service:

The minimum monthly bill for firm service shall be the monthly billing.

Minimum Annual Guaranteed Bill For Interruptible Service:

All customers who receive or contract for interruptible service under this rate schedule whose annual bill for volumes of interruptible gas actually consumed is less than \$6,000 shall pay a deficiency payment not to exceed \$1,000. This deficiency payment shall be equal to \$1,000 times a fraction whose numerator is \$6,000 less the actual bill for interruptible service and whose denominator is \$6,000. The customer's minimum annual guaranteed bill for interruptible service shall be based upon the volumes of interruptible gas consumed between August 1 and the following July 31. No minimum annual guaranteed bill obligation for interruptible service shall be effective for contracts which on July 31 have been in effect less than twelve months.

Payment:

Bills are due when rendered at the net rate shown above and shall be paid in full at any office of the Company within ten (10) days from the date mailed or otherwise delivered.

Terms of Service:

1. Company may supply gas from any standby or synthetic source, provided that the gas so supplied shall be reasonably equivalent on a BTU basis to the natural gas normally supplied hereunder.
2. Contract for service shall be in writing and specify in writing the daily and hourly rates of consumption and shall be for a minimum period of one year.

Effective:

With service on and after
February 1, 1992

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Terms of Service (cont'd)

3. The amount of
 - (a) any sales, gross receipts, franchise, excise, privilege, occupation or other tax or charge whether imposed by statute, ordinance, or franchise contract, that the Company pays to any governmental body, based on, or determined by, the sale of gas hereunder; and
 - (b) any charge paid by the Company to any gas supplier as a result of any sales, excise, gross receipts, or other taxes, license fee, or governmental charges imposed upon such supplier, based on, or determined by, the production, severance, manufacture, transportation or sale of gas hereunder, shall be added to and become a part of the charges to the customer under this rate schedule. Provided however, if any additional payments are imposed upon the customer by reason of this clause, the customer may, by thirty days notice in writing to the Company, cancel his contract and discontinue the use of natural gas service under this rate schedule.
4. When gas is delivered at a pressure in excess of 14.73 pounds per square inch absolute, then for the purpose of measurement hereunder, such volumes of gas shall be corrected to a pressure of 14.73 pounds per square inch absolute. It is assumed that the atmospheric pressure is 14.4 pounds per square inch. The measurement of gas volumes shall be adjusted for deviation from Boyle's Law in accordance with generally accepted engineering practice; provided, however, that where gas is delivered through positive displacement meters at a pressure not in excess of 20 pounds per square inch gauge, the gas shall be assumed to obey Boyle's Law.
5. Where orifice meters are used, volumes delivered shall be computed in accordance with formulae, tables and methods prescribed in Orifice Metering of Natural Gas, Gas Measurement Committee Report No. 3 of the American Gas Association published April, 1955, reprinted with

Effective:

With service on and after
February 1, 1992

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Terms of Service (cont'd)

5. (cont'd)
revisions in January, 1956. Said volumes shall be corrected for daily average flowing temperature from 60° F and specific gravity.
- Where rotary or turbine type meters are used on installations where customer's annual usage is more than 3,000,000 therms, all volumes measured by such meters shall be corrected to a base temperature of 60° F.
6. Gas purchased under this rate shall not be resold by the purchaser thereof in any manner, and the Company will discontinue service upon notice to the Customer, when it is determined that gas is being resold in violation of this provision of the rate schedule, in the event the Customer does not immediately discontinue such resale after such notice.
7. In the event either Company or its suppliers or the Customer is unable, wholly or in part, by reason of force majeure to carry out its obligations, other than to make payments for gas received, it is agreed that on giving notice of such force majeure as soon as possible after the occurrence of the cause relied on, the obligations of the Company or the Customer so far as they are affected by such force majeure, shall be suspended during the continuance of any inability so caused but for no longer period, and such cause shall as far as possible be remedied with all reasonable dispatch.
8. The term "force majeure" as employed above shall mean acts of God, strikes, lockouts, or other industrial disturbances, acts of the public enemy, war, blockades, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, washouts, arrests, and restraints of governments and people, civil disturbances, explosions, breakage or accident to machinery or lines of pipe, exhaustion or depletion of the Company's stocks of peak shaving fuel, exhaustion or depletion of the Company's supply of underground storage gas, freezing of wells or lines of pipe,

Effective:
With service on and after
February 1, 1992

A T L A N T A G A S L I G H T C O M P A N Y

LARGE COMMERCIAL INTERRUPTIBLE SERVICE

RATE I-24

Terms of Service (cont'd)

8. (cont'd)
partial or complete curtailment of deliveries to Company's suppliers as a result of force majeure under the suppliers' gas purchase contracts, inability to obtain rights-of-way or permits or materials, equipment or supplies, and any other causes, whether of the kind herein enumerated or otherwise, not within the control of the Company or its suppliers or the Customer and which by the exercise of due diligence either the Company or its suppliers or the Customer is unable to prevent or overcome. It is understood and agreed that the settlement of strikes or lockouts shall be entirely within the discretion of the person affected and the above requirement that any force majeure shall be remedied with all reasonable dispatch shall not require the settlement of strikes or lockouts when such course is inadvisable in the discretion of the person affected thereby.
9. A day, as used herein, is defined as a period of 24 consecutive hours, beginning at 8:00 a.m. Standard Time.
10. A month, as used herein, is defined as the period beginning on the first day of the calendar month and ending on the first day of the next succeeding calendar month.

Additional Terms and Provisions:

Service under this schedule is subject to the Terms of Service and Rules and Regulations of the Company, as filed with and approved by the Georgia Public Service Commission from time to time, as well as all future riders and tariff provisions made applicable to service under this schedule by the Georgia Public Service Commission from time to time, including without limitation, the Load Control Provisions, Purchased Gas Adjustment Rider, Franchise Recovery Rider and Direct Bill Take-or-Pay Gas Cost Recovery Rider.

Effective:

With service on and after
February 1, 1992

UNIT ENERGY COSTS

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: NRG COST.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

NATURAL GAS - MONTHLY CHARGES

MONTHLY CUSTOMER CHARGE	\$250	
FIRM USE CHARGE	\$1,300 PER THERM	
FORT McPHERSON	\$7,800	8,000 THERMS
FORT GILLEM	\$10,400	8,000 THERMS

CONSUMPTION: MONTHLY METER READING (MCF) X 10.29 THERMS/MCF = THERMS
COST OF FIRST 100,000 THERMS \$0.070 PER THERM
COST OF NEXT 200,000 THERMS \$0.057 PER THERM
COST OF OVER 300,000 THERMS \$0.047 PER THERM

GAS ADJUSTMENT (FIRM): \$0.397 PER THERM 91/92 AVERAGE
(SEE GAS RATE ANALYSIS)

INCREMENTAL GAS COST SAVINGS:

THE GAS ADJUSTMENT DOMINATES GAS COSTS	\$0.397 PER THERM
MOST GAS USAGE IS IN THE 100,000 THERM BLOCK	\$0.070 PER THERM
RESULTING INCREMENTAL GAS COST IS	\$0.467 PER THERM
RESULTING INCREMENTAL GAS ENERGY COST IS	\$4.670 PER MBTU

ELECTRICITY - MONTHLY CHARGES

BASE CHARGE \$55

CONSUMPTION:

KWH LESS THAN 300 X BILLING DEMAND
COST OF FIRST 50,000 KWH \$0.0600 PER KWH
COST OF NEXT 150,000 KWH \$0.0582 PER KWH
COST OF NEXT 800,000 KWH \$0.0442 PER KWH
COST OF OVER 1,000,000 KWH \$0.0410 PER KWH

KWH MORE THAN 300 X BILLING DEMAND
\$0.0115 PER KWH

BILLING DEMAND IS GREATEST OF:

- (1) CURRENT MONTHLY ACTUAL DEMAND
- (2) 95% OF HIGHEST DEMAND IN PREVIOUS JUNE THRU SEPTEMBER
- (3) 60% OF HIGHEST DEMAND IN PREVIOUS OCTOBER THRU MAY

POWER FACTOR CHARGE:

POWER FACTOR < 95% \$0.27 PER KVAR

FUEL COST RECOVERY:

\$0.0140 PER KWH

MINIMUM MONTHLY BILL:

\$55 BASE CHARGE + \$8.00 PER KW OF BILLING DEMAND
BUT NOT LESS THAN \$3,400
PLUS POWER FACTOR CHARGE AND FUEL COST RECOVERY

INCREMENTAL ELECTRIC COST SAVINGS:

$(\$0.0410 - \$0.0115) \times 300 = \$8.85$
 $\$0.0115 + \$0.0140 = \$0.0255$

NO SAVINGS FOR REDUCTION IN MONTHLY DEMAND
\$8.85/KW SAVINGS FOR REDUCTION IN ANNUAL PEAK DEMAND
\$0.0255/KWH SAVINGS FOR REDUCTION IN USAGE

WATER - MONTHLY CHARGES

CHARGE:

COST OF FIRST 3 CCF (BASE CHARGE) \$3.35
COST OF NEXT 067 CCF AT \$1.70 PER CCF
COST OF NEXT 800 CCF AT \$1.04 PER CCF
COST OF OVER 870 CCF AT \$0.72 PER CCF

SEWAGE - MONTHLY CHARGES

BASE CHARGE:

METER CONSUMPTION AT \$1.95 PER THOUSAND GALLONS

INCREMENTAL SEWAGE SAVINGS:

RESULTING INCREMENTAL WATER/SEWAGE COST IS
$0.96 + 1.95 = \$2.91$ PER THOUSAND GALLONS

748.05 GALLONS/CCF

HISTORICAL UTILITY USAGE

E M C ENGINEERS, INC.
PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 04/22/92
FILE: ENERGY.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

FORT GILLEM

DATE	ELECTRIC USAGE (KWH)	ELECTRIC DEMAND (KW)	BILLING DEMAND (KW)	ELECTRIC COST (\$)	NAT GAS USAGE (THERMS)	NAT GAS COST (\$)	WATER COST (\$)	WATER USAGE (GAL)	SEWAGE COST (\$)	SEWAGE USAGE (GAL)
FY90										
OCT	2,035,200	5,213	6,211	112,104	57,815	38,252	7,497	7,520,147	6,106	3,130,400
NOV	1,737,600	4,848	6,211	100,655	155,197	83,933	7,922	7,961,496	4,620	2,368,100
DEC	2,131,200	5,088	6,211	114,929	365,521	189,501	6,801	6,797,530	5,443	2,790,300
JAN	2,409,600	5,050	6,211	122,432	209,241	111,129	1,837	6,025,543	7,006	3,592,000
FEB	1,920,000	5,050	6,211	107,826	139,875	77,838	6,309	6,285,864	5,816	2,981,300
MAR	2,121,600	5,050	6,211	114,681	113,897	65,507	7,107	7,115,452	6,066	3,109,700
APR	1,920,000	4,877	6,211	109,315	72,354	43,701	6,360	6,338,976	5,505	2,821,900
MAY	2,236,800	5,990	6,211	117,814	14,396	17,260	7,391	7,410,183	5,095	2,611,500
JUN	2,707,200	6,557	6,557	133,423	12,782	16,619	6,964	6,966,590	4,312	2,210,000
JUL	2,755,200	6,643	6,643	135,462	12,381	16,410	6,116	6,085,387	5,124	2,626,600
AUG	3,081,600	6,643	6,643	144,232	13,431	16,860	7,139	7,148,366	5,587	2,864,000
SEP	2,515,200	6,682	6,682	129,332	13,013	16,645	6,908	6,908,242	5,440	2,788,900
TOTAL	27,571,200			1,442,205	1,179,903	693,655	78,351	82,563,776	66,120	33,894,700

FY91

OCT	2,304,000	5,875	6,348	123,598	54,080	36,171	7,479	7,501,445	6,701	3,435,100
NOV	2,054,400	4,800	6,348	116,377	124,669	57,268	7,187	7,198,485	5,275	2,704,100
DEC	2,102,400	5,136	6,348	115,893	235,094	117,969	6,777	6,772,097	4,935	2,529,800
JAN	2,150,400	5,443	6,348	117,177	299,628	143,200	10,070	10,193,677	5,903	3,029,400
FEB	2,227,200	5,290	6,348	119,362	206,257	103,367	7,082	7,089,270	6,268	3,213,500
MAR	1,958,400	5,280	6,348	112,076	135,811	73,033	6,637	6,626,227	6,525	3,344,900
APR	2,112,000	5,347	6,348	116,392	36,386	28,291	7,081	7,087,774	7,191	3,686,600
MAY	2,140,800	6,240	6,348	117,365	17,102	18,267	7,917	7,956,260	8,558	4,387,400
JUN	2,649,600	6,576	6,576	133,117	13,485	16,566	10,940	11,097,322	7,931	4,066,000
JUL	2,793,600	6,816	6,816	133,320	12,493	16,123	12,902	13,135,758	8,537	4,376,900
AUG	3,014,400	6,864	6,864	139,260	13,182	16,401	13,896	14,168,067	7,237	3,710,000
SEP	2,544,000	6,768	6,768	126,646	15,507	17,513	15,209	15,532,510	6,437	3,299,800
TOTAL	28,051,200			1,470,583	1,163,694	644,169	113,177	114,358,892	81,498	41,783,500

91/92 AVG

OCT	2,169,600	5,544	6,280	117,851	55,948	37,212	7,488	7,510,796	6,404	3,282,750
NOV	1,896,000	4,824	6,280	108,516	139,933	70,601	7,555	7,579,991	4,948	2,536,100
DEC	2,116,800	5,112	6,280	115,411	300,308	153,735	6,789	6,784,814	5,189	2,660,050
JAN	2,280,000	5,247	6,280	119,805	254,435	127,165	5,954	8,109,610	6,455	3,310,700
FEB	2,073,600	5,170	6,280	113,594	173,066	90,603	6,696	6,687,567	6,042	3,097,400
MAR	2,040,000	5,165	6,280	113,379	124,854	69,270	6,872	6,870,840	6,296	3,227,300
APR	2,016,000	5,112	6,280	112,854	54,370	35,996	6,721	6,713,375	6,348	3,254,250
MAY	2,188,800	6,115	6,280	117,590	15,749	17,764	7,654	7,683,222	6,827	3,499,450
JUN	2,678,400	6,567	6,567	133,270	13,134	16,593	8,952	9,031,956	6,122	3,138,000
JUL	2,774,400	6,730	6,730	134,391	12,437	16,267	9,509	9,610,573	6,831	3,501,750
AUG	3,048,000	6,754	6,754	141,746	13,307	16,631	10,518	10,658,217	6,412	3,287,000
SEP	2,529,600	6,725	6,725	127,989	14,260	17,079	11,059	11,220,376	5,939	3,044,350
TOTAL	8,352,000			404,126	40,004	49,976	31,085	31,489,165	19,181	9,833,100

ELECTRICITY RATE ANALYSIS

EMC PROJECT: #3105.000
 DATE: 04/22/92
 FILE: NRG COST.WK3
 PREPARED BY: DENNIS JONES
 CHECKED BY:

		FORT GILLEM										
MONTH	DAYS	ELECTRIC USAGE (KWH)	ACTUAL DEMAND (KW)	BILLING DEMAND (KW)	ELECTRIC COST (\$)	300 X DEMAND (KWH)	FIRST 1,000,000 (\$)	UP TO 300 X (\$)	OVER 300 X (\$)	TOTAL KWH (\$)	FUEL ADJUST (\$)	FUEL ADJ RATE (\$/KWH)
OCT	31	2,304,000	5,875	6,348	123,598	1,904,400	47,090	37,080	4,595	88,766	38,928	0.0169
NOV	30	2,054,400	4,800	6,348	116,377	1,904,400	47,090	37,080	1,725	85,895	34,711	0.0169
DEC	31	2,102,400	5,136	6,348	115,893	1,904,400	47,090	37,080	2,277	86,447	33,733	0.0160
JAN	31	2,150,400	5,443	6,348	117,177	1,904,400	47,090	37,080	2,829	86,999	34,503	0.0160
FEB	28	2,227,200	5,290	6,348	119,362	1,904,400	47,090	37,080	3,712	87,883	35,735	0.0160
MAR	31	1,958,400	5,280	6,348	112,076	1,904,400	47,090	37,080	621	84,791	31,423	0.0160
APR	30	2,112,000	5,347	6,348	116,392	1,904,400	47,090	37,080	2,387	86,558	33,887	0.0160
MAY	31	2,140,800	6,240	6,348	117,365	1,904,400	47,090	37,080	2,719	86,889	34,349	0.0160
JUN	30	2,649,600	6,576	6,576	133,117	1,972,800	47,090	39,885	7,783	94,758	42,513	0.0160
JUL	31	2,793,600	6,816	6,816	133,320	2,044,800	47,090	42,837	8,611	98,538	39,043	0.0140
AUG	31	3,014,400	6,864	6,864	139,260	2,059,200	47,090	43,427	10,985	101,502	42,129	0.0140
SEP	30	2,544,000	6,768	6,768	126,646	2,030,400	47,090	42,246	5,906	95,243	35,555	0.0140
TOTAL	365	28,051,200			1,470,582		565,080	465,038	54,151	1,084,270	436,510	

GAS RATE ANALYSIS – FORT GILLEM

EMC PROJECT: #3105.000
 DATE: 04/22/92
 FILE: NRG COST.WK3
 PREPARED BY: DENNIS JONES
 CHECKED BY:

MONTH	FORT GILLEM		FIRM USE CHARGE (\$)	FIRST 100,000 (\$)	NEXT 200,000 (\$)	OVER 300,000 (\$)	GAS ADJUST (\$)	ADJUST RATE (\$/THERM)	DAILY USAGE (THERMS)
	NAT GAS USAGE (THERMS)	NAT GAS COST (\$)							
OCT	55,948	37,212	\$10,400	\$4,084	\$0	\$0	\$22,477	0.4018	1,805
NOV	139,933	70,601	\$10,400	\$7,300	\$2,516	\$0	\$50,135	0.3583	4,664
DEC	300,308	153,735	\$10,400	\$7,300	\$12,600	\$16	\$123,169	0.4101	9,687
JAN	254,435	127,165	\$10,400	\$7,300	\$9,729	\$0	\$99,485	0.3910	8,208
FEB	173,066	90,603	\$10,400	\$7,300	\$4,603	\$0	\$68,049	0.3932	6,181
MAR	124,854	69,270	\$10,400	\$7,300	\$1,566	\$0	\$49,754	0.3985	4,028
APR	54,370	35,996	\$10,400	\$3,969	\$0	\$0	\$21,377	0.3932	1,812
MAY	15,749	17,764	\$10,400	\$1,150	\$0	\$0	\$5,964	0.3787	508
JUN	13,134	16,593	\$10,400	\$959	\$0	\$0	\$4,984	0.3795	438
JUL	12,437	16,267	\$10,400	\$908	\$0	\$0	\$4,709	0.3786	401
AUG	13,307	16,631	\$10,400	\$971	\$0	\$0	\$5,009	0.3764	429
SEP	14,260	17,079	\$10,400	\$1,041	\$0	\$0	\$5,388	0.3778	475
TOTAL	1,171,799	\$668,912	\$124,800	\$49,582	\$31,014	\$16	\$460,500	0.3864	3220

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 28-JAN-92

FILE: GILELEC.WK3

PREPARED BY: CAMERAN DIBA

CHECKED BY:

FORT GILLEM ELECTRICAL DEMAND

JANUARY 1991

DECIMAL TIME	1/19/91	1/20/91	1/21/91	1/22/91	1/23/91	1/24/91	1/25/91	AVERAGE WEEKDAY	AVERAGE WEEKEND
0.5	2227	2227	2179	2314	2506	2362	2246	2227	2321.4
1.0	2227	2227	2179	2304	2486	2323	2237	2227	2305.8
1.5	2246	2227	2179	2304	2496	2342	2246	2236.5	2313.4
2.0	2208	2218	2170	2323	2515	2314	2246	2213	2313.6
2.5	2227	2198	2160	2342	2477	2314	2237	2212.5	2306
3.0	2198	2179	2150	2323	2467	2314	2227	2188.5	2296.2
3.5	2218	2179	2112	2333	2515	2323	2208	2198.5	2298.2
4.0	2179	2179	2112	2323	2467	2294	2208	2179	2280.8
4.5	2227	2189	2131	2352	2534	2362	2246	2208	2325
5.0	2237	2179	2170	2496	2621	2496	2371	2208	2430.8
5.5	2342	2189	2170	2746	2832	2621	2669	2265.5	2607.6
6.0	2554	2198	2189	2880	2880	2717	2861	2376	2705.4
6.5	2899	2198	2198	3360	3274	3101	3274	2548.5	3041.4
7.0	3331	2198	2227	4166	4224	4118	4090	2764.5	3765
7.5	3427	2218	2246	4867	4906	4771	4694	2822.5	4296.8
8.0	3466	2237	2218	5232	5194	5107	4925	2851.5	4535.2
8.5	3494	2246	2227	5347	5251	5174	5050	2870	4609.8
9.0	3514	2246	2237	5376	5318	5270	5117	2880	4663.6
9.5	3571	2294	2256	5443	5280	5261	5165	2932.5	4681
10.0	3581	2304	2227	5434	5290	5270	5155	2942.5	4675.2
10.5	3610	2342	2285	5405	5386	5338	5174	2976	4717.6
11.0	3648	2390	2314	5405	5376	5299	5155	3019	4709.8
11.5	3638	2381	2314	5395	5338	5290	5146	3009.5	4696.6
12.0	3619	2381	2352	5290	5290	5280	5088	3000	4660
12.5	3466	2400	2352	5299	5290	5299	5059	2933	4659.8
13.0	3398	2400	2323	5328	5251	5280	5050	2899	4646.4
13.5	3216	2390	2333	5366	5251	5270	5030	2803	4650
14.0	3197	2371	2304	5299	5222	5203	4982	2784	4602
14.5	3053	2352	2294	5213	5155	5222	4867	2702.5	4550.2
15.0	2880	2371	2266	5184	5098	5270	4781	2625.5	4519.8
15.5	2851	2333	2285	5165	5050	5155	4790	2592	4489
16.0	2630	2314	2227	4846	4570	4579	4214	2472	4087.2
16.5	2534	2352	2227	4186	4880	3994	3494	2443	3756.2
17.0	2467	2314	2218	3792	3715	3552	3053	2390.5	3266
17.5	2429	2266	2208	3466	3370	3139	2755	2347.5	2987.6
18.0	2429	2275	2256	3187	3034	3034	2707	2352	2843.6
18.5	2419	2304	2352	2976	2890	2957	2698	2361.5	2774.6
19.0	2390	2304	2342	2861	2794	2918	2650	2347	2713
19.5	2371	2304	2352	2813	2746	2784	2611	2337.5	2661.2
20.0	2362	2294	2342	2774	2630	2746	2611	2328	2620.6
20.5	2333	2314	2342	2707	2602	2755	2554	2323.5	2592
21.0	2333	2285	2342	2688	2554	2736	2448	2309	2553.6
21.5	2275	2246	2362	2621	2486	2630	2333	2260.5	2486.4
22.0	2256	2218	2285	2573	2458	2554	2275	2237	2429
22.5	2256	2227	2352	2592	2438	2544	2275	2241.5	2440.2
23.0	2256	2198	2342	2563	2400	2496	2246	2227	2409.4
23.5	2227	2208	2333	2525	2352	2458	2256	2217.5	2384.8
24.0	2218	2170	2294	2515	2352	2448	2246	2194	2371

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

CO:

CLIENT CONTRACT NO: DACA21-91-G-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 28-JAN-92

FILE: GILELEC.WK3

PREPARED BY: CAMERAN DIBA

CHECKED BY:

FORT GILLEM ELECTRICAL DEMAND

AUGUST 1992

DECIMAL TIME	8/3/91	8/4/91	8/5/91	8/6/91	8/7/91	8/8/91	8/9/91	AVERAGE WEEKDAY	AVERAGE WEEKEND
0.5	2947	2957	2928	3158	3254	3187	3283	1437.273	2952
1.0	2899	2928	2870	3139	3187	3149	3216	2091.4	2913.5
1.5	2861	2880	2832	3101	3139	3110	3178	2336.55	2870.5
2.0	2813	2832	2784	3034	3101	3062	3110	2472.88	2822.5
2.5	2755	2813	2813	3053	3139	3082	3101	2567	2784
3.0	2736	2822	2755	3014	3091	3082	3053	3066.833	2779
3.5	2765	2765	2746	2976	3043	3005	3043	3033.6	2765
4.0	2736	2755	2707	2976	2986	2995	3014	3004.167	2745.5
4.5	2726	2698	2736	2986	2966	3005	3053	2983.7	2712
5.0	2698	2698	2822	3072	3062	3110	3158	2988.133	2698
5.5	2669	2707	2947	3254	3206	3293	3302	3015.267	2688
6.0	2650	2650	2966	3283	3283	3370	3389	3058.467	2650
6.5	2688	2717	3350	3619	3658	3782	3754	3170.133	2702.5
7.0	2726	2678	4253	4483	4502	4646	4493	3426.767	2702
7.5	2669	2669	5011	5174	5126	5222	5165	3791.833	2669
8.0	2698	2678	5539	5626	5558	5731	5568	5604.4	2688
8.5	2832	2765	5798	5942	5808	6019	5933	5900	2798.5
9.0	3005	2832	5971	6115	5981	6144	6038	6049.8	2918.5
9.5	3101	2918	6106	6163	6144	6298	6230	6188.2	3009.5
10.0	3197	3043	6134	6307	6202	6403	6307	6270.6	3120
10.5	3226	3139	6269	6403	6298	6499	6422	6378.2	3182.5
11.0	3312	3216	6307	6422	6336	6509	6509	6416.6	3264
11.5	3350	3264	6442	6566	6480	6566	6442	6499.2	3307
12.0	3350	3350	6480	6634	6538	6576	6374	6520.4	3350
12.5	3446	3370	6480	6672	6643	6614	6394	6560.6	3408
13.0	3485	3427	6528	6768	6653	6672	6480	6620.2	3456
13.5	3504	3475	6634	6787	6701	6730	6470	6664.4	3489.5
14.0	3533	3504	6643	6787	6653	6730	6490	6660.6	3518.5
14.5	3542	3590	6710	6835	6672	6768	6528	6702.6	3566
15.0	3629	3562	6730	6864	6710	6730	6547	6716.2	3595.5
15.5	3552	3542	6691	6749	6720	6634	6499	6658.6	3547
16.0	3562	3504	6086	6115	6192	6067	5693	6030.6	3533
16.5	3581	3494	5290	5261	5395	5242	4963	5230.2	3537.5
17.0	3514	3485	4790	4858	4867	4838	4541	4778.8	3499.5
17.5	3494	3418	4502	4560	4637	4560	4291	4510	3456
18.0	2446	3398	4205	4406	4397	4397	4186	4318.2	2922
18.5	3370	3360	4051	4234	4128	4195	3994	4120.4	3365
19.0	3264	3302	3888	4022	3965	4090	3734	3939.8	3283
19.5	3226	3245	3830	3926	3878	3974	3581	3837.8	3235.5
20.0	3149	3178	3706	3888	3782	3888	3379	3728.6	3163.5
20.5	3178	3139	3686	3830	3706	3782	3293	3659.4	3158.5
21.0	3158	3139	3677	3725	3696	3686	3283	3613.4	3148.5
21.5	3178	3158	3571	3590	3571	3610	3178	3504	3168
22.0	3149	3120	3485	3485	3533	3533	3130	3433.2	3134.5
22.5	3062	3043	3379	3379	3456	3485	3082	3356.2	3052.5
23.0	3034	3062	3341	3389	3312	3408	3034	3296.8	3048
23.5	3005	2976	3283	3322	3283	3350	3024	3252.4	2990.5
24.0	3005	2966	3197	3274	3235	3293	2947	3189.2	2985.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 28-JAN-92

FILE: GILELEC.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

FORT GILLEM ELECTRICAL DEMAND

JANUARY 1992

DECIMAL TIME	1/11/92	1/12/92	1/13/92	1/14/92	1/15/92	1/16/92	1/17/92	AVERAGE WEEKDAY	AVERAGE WEEKEND
0.5	2266	2160	2045	2112	2438	2429	2477	2300.2	2213
1.0	2237	2179	2006	2122	2381	2419	2477	2281	2208
1.5	2237	2141	2016	2112	2371	2410	2458	2273.4	2189
2.0	2266	2179	2026	2093	2362	2429	2486	2279.2	2222.5
2.5	2275	2189	2016	2122	2352	2448	2496	2286.8	2232
3.0	2237	2189	2035	2093	2381	2458	2506	2294.6	2213
3.5	2266	2189	1997	2093	2400	2419	2506	2283	2227.5
4.0	2294	2170	1997	2074	2410	2486	2582	2309.8	2232
4.5	2275	2170	2006	2102	2410	2496	2544	2311.6	2222.5
5.0	2275	2170	2160	2237	2554	2621	2650	2444.4	2222.5
5.5	2323	2179	2285	2429	2746	2669	2678	2561.4	2251
6.0	2563	2179	2467	2582	2842	2746	2803	2688	2371
6.5	2880	2246	2938	2995	3226	3197	3254	3122	2563
7.0	3014	2314	3686	3869	4003	4090	4186	3966.8	2664
7.5	3062	2438	4358	4406	4608	4810	4858	4608	2750
8.0	3043	2419	4723	4781	4982	5184	5136	4961.2	2731
8.5	3110	2410	4762	4867	5078	5328	5242	5055.4	2760
9.0	3168	2448	4858	4973	5194	5328	5261	5122.8	2808
9.5	3206	2496	4886	5078	5251	5395	5290	5180	2851
10.0	3264	2506	4896	5088	5261	5405	5280	5186	2885
10.5	3254	2506	4848	5078	5213	5386	5222	5149.4	2880
11.0	3216	2515	4810	5098	5213	5395	5242	5151.6	2865.5
11.5	3197	2515	4771	5088	5184	5434	5232	5141.8	2856
12.0	3130	2486	4810	5098	5155	5386	5174	5124.6	2808
12.5	2755	2477	4800	5107	5155	5328	5126	5103.2	2616
13.0	2707	2448	4762	5098	5088	5309	5078	5067	2577.5
13.5	2669	2448	4762	5050	5059	5318	5040	5045.8	2558.5
14.0	2602	2429	4752	5069	5040	5290	5021	5034.4	2515.5
14.5	2525	2400	4733	5059	5040	5280	4992	5020.8	2462.5
15.0	2467	2362	4666	5050	4973	5155	4915	4951.8	2414.5
15.5	2448	2333	4598	4954	4906	5107	4838	4880.6	2390.5
16.0	2381	2304	4051	4483	4349	4541	4022	4289.2	2342.5
16.5	2362	2256	3418	3888	3754	3974	3350	3676.8	2309
17.0	2285	2189	3034	3466	3389	3562	2995	3289.2	2237
17.5	2246	2150	2822	3216	3168	3350	2803	3071.8	2198
18.0	2246	2179	2678	3043	2957	3091	2698	2893.4	2212.5
18.5	2275	2218	2582	2928	2918	2966	2717	2822.2	2246.5
19.0	2256	2189	2534	2832	2861	2918	2611	2751.2	2222.5
19.5	2237	2141	2477	2842	2803	2870	2544	2707.2	2189
20.0	2237	2131	2362	2774	2736	2851	2496	2643.8	2184
20.5	2227	2131	2304	2736	2746	2822	2486	2618.8	2179
21.0	2218	2122	2275	2688	2678	2707	2477	2565	2170
21.5	2179	2093	2227	2659	2611	2640	2410	2509.4	2136
22.0	2170	2064	2179	2515	2621	2602	2400	2463.4	2117
22.5	2160	2054	2141	2467	2621	2592	2381	2440.4	2107
23.0	2179	2056	2150	2458	2573	2534	2381	2419.2	2117.5
23.5	2170	2035	2122	2467	2506	2496	2362	2390.6	2102.5
24.0	2170	2035	2083	2448	2448	2467	2323	2353.8	2102.5

APPENDIX C

ENERGY CONSERVATION OPPORTUNITY BACKUP CALCULATIONS

<u>Section</u>	<u>ECO Description</u>
C-1.1	WALL INSULATION
C-1.2	ROOF INSULATION
C-1.3	PIPE AND DUCT INSULATION
C-2	INSULATED GLASS
C-3	WEATHERSTRIPPING AND CAULKING
C-4	MEASURE HOT WATER TEMPERATURES
C-5	ELECTRIC MOTORS
C-6	ADD ECONOMIZERS
C-7	CONTROL HOT WATER CIRCULATION PUMPS
C-8	INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES
C-9	HEAT RECLAIM FOR HOT REFRIGERANT GAS
C-10	PREVENT AIR STRATIFICATION
C-11	REPLACE STREET LIGHTS
C-12	REVISE OR REPAIR HVAC CONTROLS
C-13	THERMAL STORAGE
C-14.1	LOADING DOCK SEALS
C-14.2	RADIANT HEATERS
C-15.1	BUILDING 200 LIGHTING CONTROLS
C-15.2	SEPARATE SWITCHES TO CONTROL LIGHTING
C-16	INVESTIGATE POST DEMAND USAGE
C-17	EVALUATE BOILER OPERATION
C-18	EXIT SIGN RETROFIT
C-19	LIGHTING UPGRADES
C-20	COMPUTER SIMULATION SUMMARIES

APPENDIX C-1.1
WALL INSULATION

**WALL INSULATION SAMPLE CALCULATION, ECO #1
BUILDING 505 (GILLEM)**

Given:

Gross Wall Area	= 31,400 ft ²	- from bldg plans
Window Area	= 8,068 ft ²	- from bldg plans / survey notes
Existing Wall U-value	= 0.184 Btuh / hr °F ft ²	- from survey notes
Improved Wall U-value	= 0.065 Btuh / hr °F ft ²	- from survey notes
Gas Savings Factor	= 0.021 MBtu / UA	- from Bldg 100 simulation
Electric Savings Factor	= 0.81 kWh / UA	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Net Wall Area:

$$31,400 \text{ ft}^2 - 8,068 \text{ ft}^2 = 23,332 \text{ ft}^2$$

Existing Wall UA:

$$(23,332 \text{ ft}^2) * (0.184 \text{ Btuh / hr °F ft}^2) = 4,293 \text{ Btuh / hr °F}$$

Improved Wall UA:

$$(23,332 \text{ ft}^2) * (0.065 \text{ Btuh / hr °F ft}^2) = 1,517 \text{ Btuh / hr °F}$$

Delta UA:

$$4,293 - 1,517 = 2,777 \text{ Btuh / hr °F}$$

Peak Demand Savings:

$$(2,777 \text{ UA}) * (0.0 \text{ kW / UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

- Gas:	(2,777 UA) * (0.021 MBtu / UA)	= 58.3 MBtu
- Electric:	(2,777 UA) * (0.81 kWh / UA)	= 2,249.4 kWh

Annual Cost Savings:

$$(58.3 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (2,249.4 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$330 / \text{yr}$$

Estimated Construction Cost:

\$4.04 / ft² of wall - from engineer's cost estimate

$$(\$4.04 / \text{ft}^2) * (23,332 \text{ ft}^2) = \$94,261$$

$$\$94,261 + (\$94,261 * .055 \text{ SIOH}) + (\$94,261 * .06 \text{ DESIGN}) = \$105,101$$

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 - Wall Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 23 APRIL 1992
FILE: ECO-1W.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

ENERGY COST			DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG	
Electric Savings	\$0.0255 / kWh	15.61 UPWE	
Demand Savings	\$8.85 / kW	14.53 UPW	

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	19	18,111	217	279	\$1,477	\$1,921	\$0	\$3,398	\$135,814	0.4	40
207	0	2,920	76	86	\$430	\$0	\$0	\$430	\$135,899	0.1	316
505	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
506	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
507	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
508	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
509	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
510	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
511	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
512	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
513	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319
514	0	2,249	58	66	\$330	\$0	\$0	\$330	\$105,101	0.1	319

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 1 - Wall Insulation

EMC PROJECT: #3105.000
 DATE: 15-APR-92
 FILE: ECO-1W.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

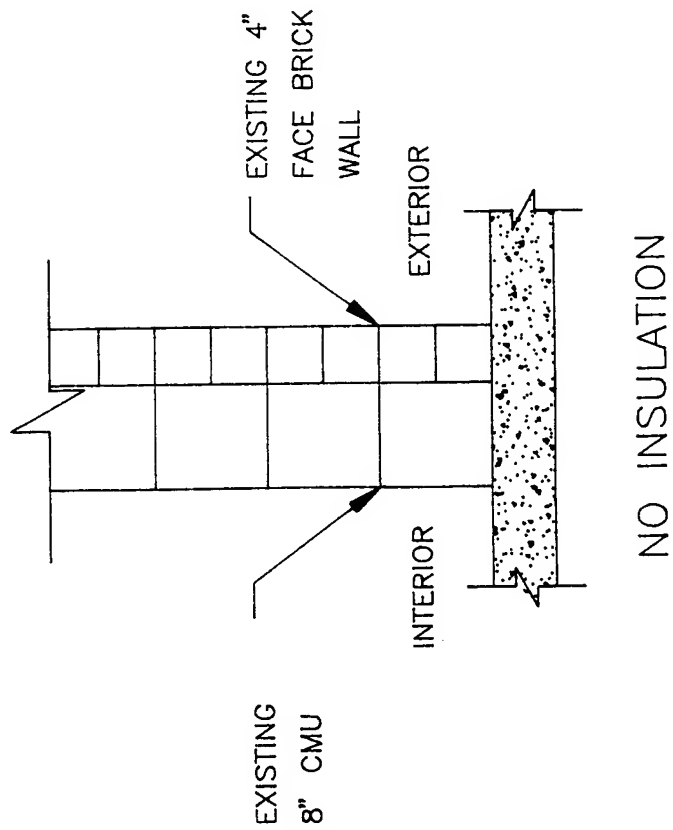
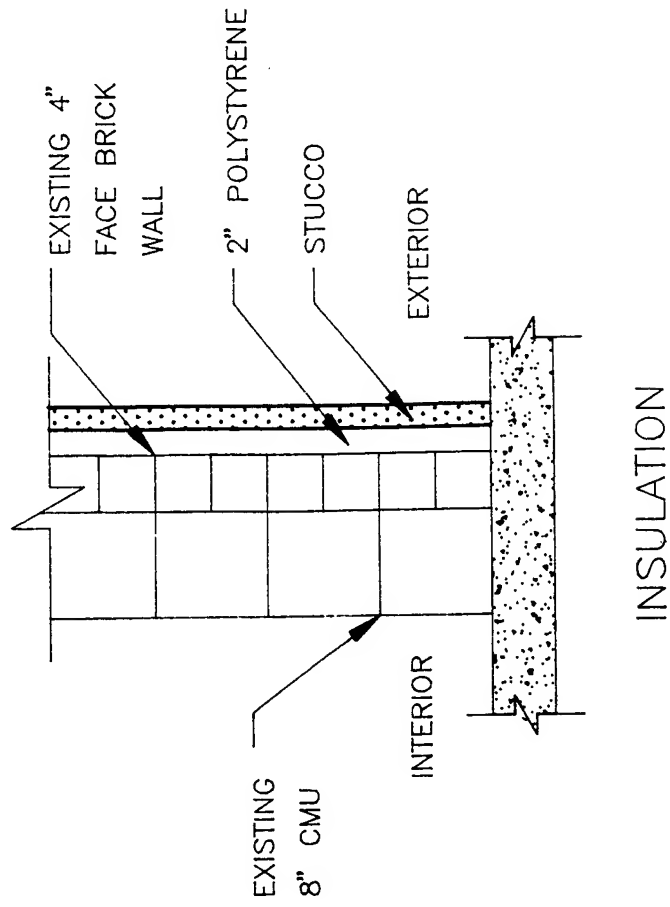
CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	WIN AREA (ft²)	GROSS WALL AREA (ft²)	NET WALL AREA (ft²)	EXIST WALL U-VALUE	EXIST WALL UA	IMPRVD WALL U-VALUE	IMPRVD WALL UA	DELTA UA	DEMAND SAVINGS (kW/UA)	ELECTRIC SAVINGS (kWh/UA)	GAS SAVINGS (MBtu/UA)	PEAK DEMAND SAVINGS (kW/yr)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST (\$/ft²)	CONST COST (\$)
101			35,512	0.25	8,878	0.08	2,841	6,037	0.0031	3.0	0.036	18.7	18,111	217	\$3.43	\$121,806
207			30,169	0.184	5,551	0.065	1,961	3,590	0	0.81	0.021	0	2,920	76	\$4.04	\$121,883
505	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
506	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
507	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
508	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
509	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
510	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
511	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
512	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
513	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261
514	8,068	31,400	23,332	0.184	4,293	0.065	1,517	2,777	0	0.81	0.021	0	2,249	58	\$4.04	\$94,261

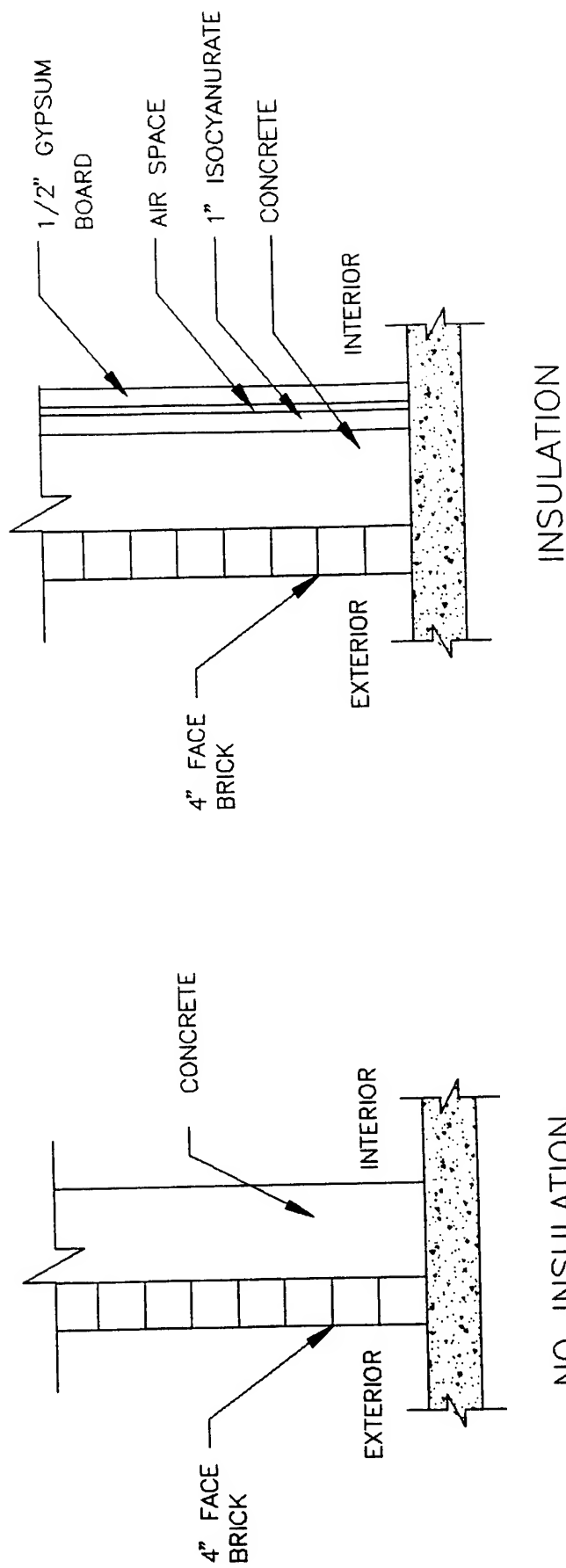
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C-1.1.6

ADD 2" POLYSTYRENE AND STUCCO



ADD 1" ISOCYANURATE AND GYPSUM BOARD



APPENDIX C-1.2
ROOF INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 ROOF INSULATION

ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 3173436.
B. SIOH	\$ 174539.
C. DESIGN COST	\$ 190407.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 3538382.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	3041.	\$ 22723.	15.61	354701.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	34889.	\$ 162932.	23.77	3872885.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		37930.	\$ 185654.		\$ 4227586.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	14.53	\$ 0.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)\$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 1395103.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 185654.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 4227586.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.19
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 19.06

**ROOF INSULATION SAMPLE CALCULATION, ECO #1
BUILDING 111**

Given:

Roof Area	= 2,150 ft ²	- from bldg plans
Existing Roof U-value	= 0.202 Btuh / hr °F ft ²	- from survey notes
Improved Roof U-value	= 0.042 Btuh / hr °F ft ²	- from survey notes
Gas Savings Factor	= 0.0083 MBtu / UA	- from Bldg 100 simulation
Electric Savings Factor	= 1.8 kWh / UA	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Roof UA:

$$(2,150 \text{ ft}^2) * (0.202 \text{ Btuh / hr } ^\circ\text{F ft}^2) = 434.3 \text{ Btuh / hr } ^\circ\text{F}$$

Improved Roof UA:

$$(2,150 \text{ ft}^2) * (0.042 \text{ Btuh / hr } ^\circ\text{F ft}^2) = 90.3 \text{ Btuh / hr } ^\circ\text{F}$$

Delta UA:

$$434.3 - 90.3 = 344.0 \text{ Btuh / hr } ^\circ\text{F}$$

Peak Demand Savings:

$$(344.0 \text{ UA}) * (0.0 \text{ kW / UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

- Gas:	$(344.0 \text{ UA}) * (0.0083 \text{ MBtu / UA})$	= 2.9 MBtu
- Electric:	$(344.0 \text{ UA}) * (1.8 \text{ kWh / UA})$	= 619 kWh

Annual Cost Savings:

$$(2.9 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (619 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$29 / \text{yr}$$

Estimated Construction Cost:

\$0.68 / ft² of wall - from engineer's cost estimate

$$(\$0.68 / \text{ft}^2) * (2,150 \text{ ft}^2) = \$1,462$$

$$\$1,462 + (\$1,462 * .055 \text{ SIOH}) + (\$1,462 * .06 \text{ DESIGN}) = \$1,630$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 - Roof Insulation

EMC PROJECT: #3105.000
DATE: 01-Sep-92
FILE: ECO-1R.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
505	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
506	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
507	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
508	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
509	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
510	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
511	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
512	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
513	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
514	0	78,255	3,078	3,345	\$16,370	\$0	\$0	\$16,370	\$311,888	1.2	19
207	0	108,540	4,109	4,479	\$21,957	\$0	\$0	\$21,957	\$419,503	1.2	19
TOTAL	0	891,090	34,889	37,928	\$185,656	\$0	\$0	\$185,656	\$3,538,381	1.2	19

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 1 - Roof Insulation

EMC PROJECT: #3105.000
 DATE: 15-APR-92
 FILE: ECO-1R.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	ROOF AREA (ft ²)	EXIST ROOF U-VALUE	EXIST ROOF UA	IMPRVD ROOF U-VALUE	IMPRVD ROOF UA	DELTA UA	DEMAND SAVINGS (kW/UA)	ELECTRIC SAVINGS (kWh/UA)	GAS SAVINGS (MBtu/UA)	PEAK DEMAND SAVINGS (kW/yr)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST (\$/ft ²)	CONST COST (\$)
207	149,300	0.518	77,337	0.048	7,166	70,171	0	1.5	0.059	0	108,540	4,109	\$2.52	\$376,236
505	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
506	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
507	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
508	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
509	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
510	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
511	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
512	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
513	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
514	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720

EFFECTIVE PRICING DATE PREPARED

LOCATION Ft. McPherson & Ft. Gillem

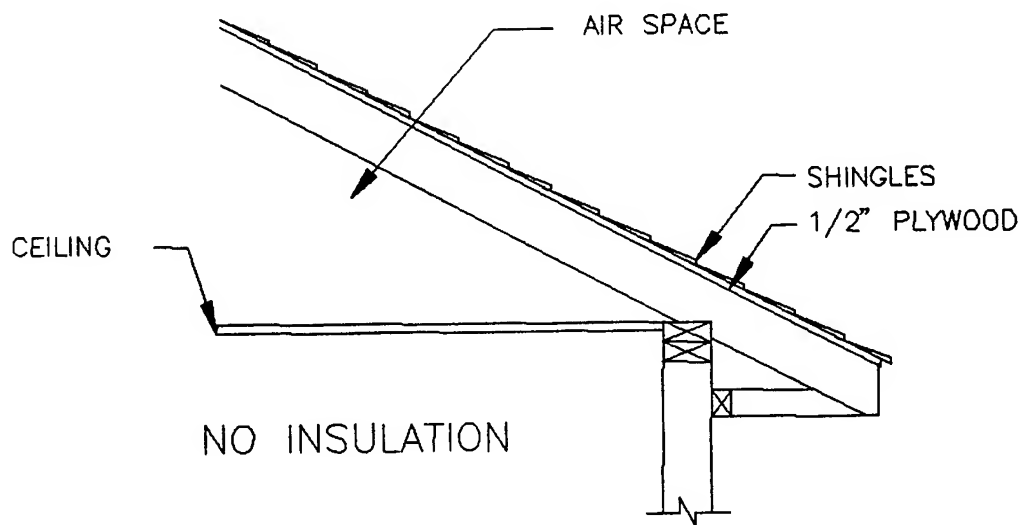
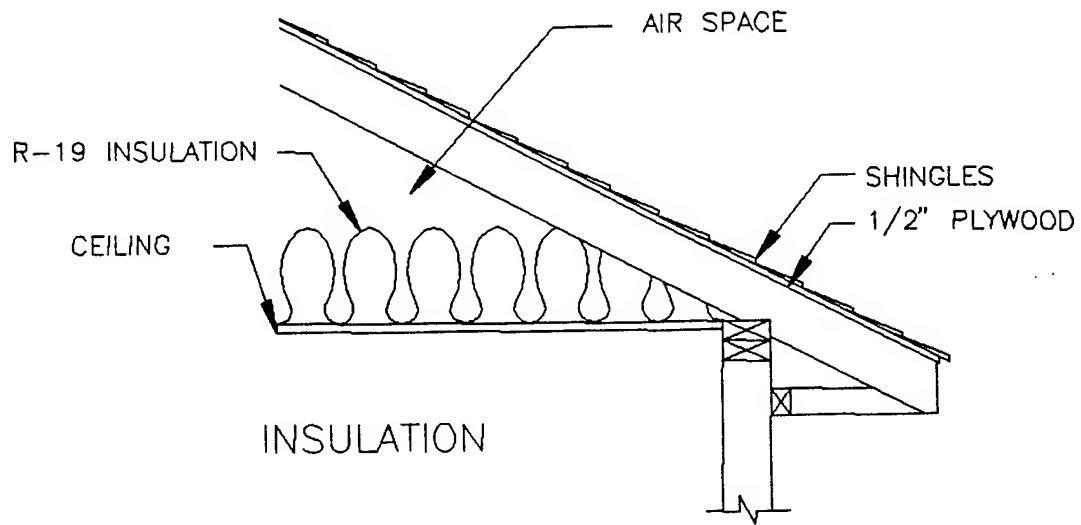
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DATE APR 92

16-Apr-97

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APPENDIX C-1.3
PIPE AND DUCT INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25
LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 DUCT INSULATION

ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	1830.
B. SIOH	\$	101.
C. DESIGN COST	\$	110.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	2041.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	16.	\$ 117.	15.61	1830.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	38.	\$ 177.	23.77	4218.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		54.	\$ 295.		\$ 6048.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	14.53	\$	0.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$	0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)\$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 1996.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 295.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 6048.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.96
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.93

DUCT INSULATION SAMPLE CALCULATION, ECO #1 BUILDING G101

Given:

Duct Perimeter	= 80 in	- from bldg plans / survey notes
Duct Length	= 45 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 0.5 in	- from survey notes
Improved Ins. Thickness	= 2.0 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft ² °F	- from ASHRAE
Inner Film R-Value	= 0.22 ft ² °F / Btuh	- from ASHRAE
Outer Film R-Value	= 0.65 ft ² °F / Btuh	- from ASHRAE
Duct Temp. -Heating	= 90 °F	- assumed
Duct Temp. -Cooling	= 55 °F	- assumed
Amb. Temp. Winter	= 75 °F	- assumed
Amb. Temp. Summer	= 90 °F	- assumed
Delta Enthalpy - Summer	= 15.6 Btu / lbm	- assumed
Leakage Class w/o insul.	= 48 cfm / 100ft ²	- SMACNA
Leakage Class w/ added insul	= 24 cfm / 100 ft ²	- SMACNA
Static Pressure	= 0.5 in. w.g.	- assumed
Gas Heater Efficiency	= 75%	- assumed
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Duct Surface Area:

$$(80 \text{ in} / 12 \text{ in} / \text{ft}) * (45 \text{ ft}) = 300 \text{ ft}^2$$

Existing Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F}) / (0.5 \text{ in})) = 1.92 \text{ ft}^2 \text{ °F} / \text{Btuh}$$

Existing U-Value:

$$1 / (0.22 + 1.92 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.36 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

Improved Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F}) / (2.0 \text{ in})) = 7.69 \text{ ft}^2 \text{ °F} / \text{Btuh}$$

Improved U-Value:

$$1 / (0.22 + 7.69 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.12 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

Existing Leakage Rate:

$$(48 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 30.6 \text{ cfm} / 100 \text{ ft}^2$$

Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 75 \text{ } ^\circ\text{F}) / 0.75 = 2,160 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm } ^\circ\text{F}) * (91.8 \text{ cfm})(90 - 75 \text{ } ^\circ\text{F})}{0.75} = 2020 \text{ Btuh}$$

Total

$$(2020 + 2160) = 4180 \text{ Btuh}$$
$$(4180 \text{ Btuh}) * (4380 \text{ hrs}) = 18.3 \text{ MBtu}$$

Summer (electric):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 55 \text{ } ^\circ\text{F}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.38 \text{ kW}$$

Total

$$(0.22 + 0.38) = 0.60 \text{ kW}$$
$$(0.60 \text{ kW}) * (4380 \text{ hrs}) = 2628 \text{ kwh}$$

Improved Energy Usage:

Winter (gas):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 75 \text{ } ^\circ\text{F}) / 0.75 = 701 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm } ^\circ\text{F}) * (45.9 \text{ cfm})(90 - 75 \text{ } ^\circ\text{F})}{0.75} = 1010 \text{ Btuh}$$

Total

$$(7.1 + 1010) = 1711 \text{ Btuh}$$
$$(1711 \text{ Btuh}) * (4380 \text{ hrs}) = 7.5 \text{ MBtu}$$

Summer (electric):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 55 \text{ } ^\circ\text{F}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.071 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) * (45.9 \text{ cfm}) (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.19 \text{ kw}$$

Total

$$(0.071 + 0.19) = 0.26 \text{ kw}$$
$$(0.26 \text{ kw}) * (4380 \text{ yrs}) = 1134 \text{ kwh}$$

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:	(2628 - 1134 kWh)	= 1494 kW
- Gas:	(18.3 - 7.5 MBtu)	= 10.8 MBtu

Annual Cost Savings:

$$(10.8 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (1494 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$89 / \text{yr}$$

Estimated Construction Cost:

\$3.05 / ft² of insulation - from engineer's cost estimate

$$(\$3.05 / \text{ft}^2) * (300 \text{ ft}^2) = \$915$$

$$\$915 + (\$915 * .055 \text{ SIOH}) + (\$915 * .06 \text{ DESIGN}) = \$1,020$$

**PIPE INSULATION SAMPLE CALCULATION, ECO #1
BUILDING G101**

Given:

Pipe Diameter	= 2.0 in	- from bldg plans / survey notes
Pipe Length	= 100 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 1.0 in	- from survey notes
Improved Ins. Thickness	= 1.5 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft ² °F	- from ASHRAE
Fluid Temperature	= 140 °F	- assumed
Amb. Temperature	= 50 °F	- assumed
Gas Boiler Efficiency	= 75%	- assumed
Gas Cost	= \$4.70 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Conductance Coefficient:

$$\ln((2 + 2 * 1.0)/2)/(2 * \pi * ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F})/(12 \text{ in} / \text{ft})) \\ = 5.09 \text{ ft °F} / \text{Btuh}$$

Existing Pipe Surface Temperature:

$$\text{assume } R_c = 1 \text{ ft °F} / \text{Btuh}$$

$$(50 \text{ °F}) + (140 - 50 \text{ °F}) * (1 \text{ ft °F} / \text{Btuh}) / (1 + 5.09 \text{ ft °F} / \text{Btuh}) \\ = 64.8 \text{ °F}$$

Existing Convection Coefficient:

$$h_c = 0.18 * (64.8 - 40) ^{0.33} = 0.52 \text{ Btuh} / \text{ft}^2 \text{ °F} \\ A = \pi * 2 \text{ in} * (1 \text{ ft} / 12 \text{ in}) = 0.52 \text{ ft}^2 / \text{ft}$$

$$1 / ((0.52 \text{ Btuh} / \text{ft}^2 \text{ °F}) * (0.52 \text{ ft}^2 / \text{ft})) = 3.68 \text{ ft °F} / \text{Btuh}$$

After 5 iterations:

$$T_s = 74.1 \text{ °F} \\ R_c = 1.86 \text{ ft °F} / \text{Btuh}$$

Existing Combined Coefficient of Resistance:

$$5.09 + 1.86 = 6.95 \text{ ft °F} / \text{Btuh}$$

Existing Annual Energy Loss:

$$(140 - 50 \text{ °F}) * (100 \text{ ft}) / ((6.95 \text{ ft °F} / \text{Btuh}) * (0.75)) = 1,727 \text{ Btuh}$$

$$(1,727 \text{ Btuh}) * (4,380 \text{ hrs/yr}) = 7.6 \text{ MBtu/yr}$$

Improved Conductance Coefficient:

$$\ln((2 + 2 * 1.5)/2) / (2 * \pi * ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ } ^\circ\text{F}) / (12 \text{ in} / \text{ft}))) \\ = 6.73 \text{ ft } ^\circ\text{F} / \text{Btuh}$$

Improved Pipe Surface Temperature:

$$\text{assume } R_c = 1 \text{ ft } ^\circ\text{F} / \text{Btuh}$$

$$(50 \text{ } ^\circ\text{F}) + (140 - 50 \text{ } ^\circ\text{F}) * (1 \text{ ft } ^\circ\text{F} / \text{Btuh}) / (1 + 6.73 \text{ ft } ^\circ\text{F} / \text{Btuh}) \\ = 61.6 \text{ } ^\circ\text{F}$$

Improved Convection Coefficient:

$$h_c = 0.18 * (61.6 - 40) ^{0.33} = 0.50 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}$$

$$A = \pi * 2 \text{ in} * (1 \text{ ft} / 12 \text{ in}) = 0.52 \text{ ft}^2 / \text{ft}$$

$$1 / ((0.50 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (0.52 \text{ ft}^2 / \text{ft})) = 3.85 \text{ ft } ^\circ\text{F} / \text{Btuh}$$

After 5 iterations:

$$T_s = 67.7 \text{ } ^\circ\text{F}$$

$$R_c = 1.65 \text{ ft } ^\circ\text{F} / \text{Btuh}$$

Improved Combined Coefficient of Resistance:

$$6.73 + 1.65 = 8.38 \text{ ft } ^\circ\text{F} / \text{Btuh}$$

Improved Energy Loss:

$$(140 - 50 \text{ } ^\circ\text{F}) * (100 \text{ ft}) / ((8.38 \text{ ft } ^\circ\text{F} / \text{Btuh}) * (0.75)) = 1,431 \text{ Btuh} \\ (1,431 \text{ Btuh}) * (4,380 \text{ hrs/yr}) = 6.3 \text{ MBtu/yr}$$

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:		= 0 kW
- Gas:	(7.6 - 6.3 MBtu)	= 1.3 MBtu

Annual Cost Savings:

$$(1.3 \text{ MBtu}) * (\$4.70 / \text{MBtu}) + (0 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 \\ * 8) = \$6 / \text{yr}$$

Estimated Construction Cost:

\$4.57 / ft of 1-1/2" insulation on 2" pipe - from engineer's cost estimate

$$(\$4.57 / \text{ft}) * (100 \text{ ft}) = \$457$$

1,334 -small construction cost

$$\$457 + \$1,334 = \$1791$$

$$\$1791 + (\$1791 * .055 \text{ SIOH}) + (\$1791 * .06 \text{ DESIGN}) = \$1,997$$

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 — Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW
Economic Life: 25 yrs		

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
G735	0	3,770	32	45	\$246	\$0	\$0	\$246	\$1,020	5.0	4.2
G101	0	826	6	9	\$49	\$0	\$0	\$49	\$1,020	1.0	20.8
TOTAL	0	4,596	38	54	\$295	\$0	\$0	\$295	\$2,040	3.0	6.9

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
ECO: 1 — Pipe Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE: 20-Jul-92
 FILE: ECO-G1P.WK3
 PREPARED BY: CMD
 CHECKED BY: CEL

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	0	0	7.30	7	\$34	\$0	\$0	\$34	\$1,997	0.4	58.6

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: GDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

HOT WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INSULATION (IN)	REMARKS
			THICKNESS (IN)	TYPE		
G101	2	100	1	Fiberglass	1.5	
	4	200	2	Fiberglass	1.5	DTW Pipe
G735	2	30	2	Fiberglass	1.5	

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: GDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

STEAM PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INSULATION (IN)	REMARKS
			THICKNESS (IN)	TYPE		
G101	1	200	1	Fiberglass	2	
G735	N/A	-	-	-	-	

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: GDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CHILLED WATER PIPES

BLDG #	PIPE DIA. (IN)	LENGTH (FT)	SURVEY		REQUIRED INS. (IN)
			THICKNESS (IN)	TYPE	
G101	3	200	2	Fiberglass	1
G735	N/A	-	-	-	-

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 17-Apr-92

FILE: GDUCTPIPE.WK3

PREPARED BY: CMD

CHECKED BY: CEL

DUCTS

BLDG #	DUCT SIZE (IN)	PERIMETER LENGTH	DUCT LENGTH (FT)	THICKNESS (IN)	SURVEY TYPE	REQUIRED INS. (IN)
G101	20 * 20	80	700	good	Fiberglass	2
G735	20 * 20	80	25	0	-	2
	40 * 40	160	10	0	-	2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: GDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

Energy cost:

Gas: \$4.70 / MBtu

Electric: 0.0255 / KWH

EXISTING PIPE INSULATION CONDITION

BLDG#	PIPE DIA (in)	PIPE LENGTH (ft)	PIPE INSUL THICK (in)	k Btu-h in/ ft ² -°F	FLUID TEMP (°F)	AMB TEMP (°F)	Rc (F/Btu-h)	SURFACE TEMP (F/Btu-h)	COND. R (F/Btu-h)	CONV. R (F/Btu-h)	TOTAL R (F/Btu-h)	EXIST TOTAL LOSS (Btu-h)	ANNUAL ENERGY LOSS (MBtu/yr)	ANNUAL ENERGY LOSS (KWH/yr)	ANNUAL ENERGY COST (\$/yr)
G101	2	100	1	0.26	140	50	1.86	74.05	5.09	1.86	6.95	1,295	7.56	-	\$35.55
	1	200	1	0.29	255	50	2.02	94.71	7.24	2.02	9.25	4,431	25.88	-	\$121.61

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: DUCT AND PIPE INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Apr-92
FILE: GDUCTPIPE.WK3
PREPARED BY: CMD
CHECKED BY: CEL

Energy cost: Gas: \$4.70 / MBtu
Electric: 0.0255 / KWH

NEW PIPE INSULATION CONDITION

BLDG#	PIPE DIA (in)	PIPE LENGTH (ft)	INSUL THICK (in)	k	FLUID TEMP (F)	AMB TEMP (F)	Rc (F/Btu)	SURFACE TEMP (F/Btu)	COND. R (F/Btu)	CONV. R (F/Btu)	TOTAL R (F/Btu)	IMPROVED ENERGY LOSS (Btu/h)	ANNUAL GAS LOSS (MBtu/yr)	ANNUAL ELECTRIC LOSS (KWH/yr)	ANNUAL ELECTRIC SAVINGS (KWH/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	ENERGY COST (\$/yr)	ANNUAL SAVINGS (\$/yr)
G101	2	100	1.5	0.26	140	50	1.64	67.67	6.73	1.65	8.38	1,075	6.28	-	0	0	29.49	\$6.06
	1	200	2	0.29	255	50	1.47	74.94	10.60	1.47	12.07	3,398	19.84	-	0	0	93.25	\$28.36

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 – Duct Insulation

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXISTING DUCT INSULATION CONDITION

BLDG. #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft ²)	R OUTER FILM	R INNER FILM	R INS.	U	THERMAL COND. (Btu in/ h ft ² F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft ²)	TOTAL LEAK (cfm)	WINTER		SUMMER		
														DUCT TEMP (F)	AMB TEMP (F)	DUCT TEMP (F)	AMB TEMP (F)	DELTA ENTH
G101	80	45	300	0.65	0.220	1.92	0.36	0.26	0.5	0	0.5	0.0	0.0	90	75	55	90	15.6
G735	80	25	167	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	51.0	90	75	55	90	15.6
	160	10	133	0.65	0.220	0.00	1.15	0.26	0	48	0.5	30.6	40.8	90	75	55	90	15.6

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT McPHERSON
ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EXISTING DUCT INSULATION CONDITION

EMC PROJECT: #3105.000
 DATE: 10-JUL-92
 FILE: ECO-1DG.WK3
 PREPARED BY: CMD
 CHECKED BY: CEL

BLDG #	ENERGY LOSSES							
	WINTER			SUMMER			ANNUAL	
	INSUL (Btu/h)	LEAK (Btu/h)	TOTAL (Btu/h)	INSUL (kW)	LEAK (kW)	TOTAL (kW)	GAS (MBtu/yr)	ELECTRIC (kW/yr)
G101	2148.2	--	2148.2	0.22	--	0.22	9.4	960.0
G735	3831.4	1121.6	4953.0	0.39	0.21	0.60	21.7	2626.0
	3065.1	897.3	3962.4	0.31	0.17	0.48	17.4	2100.8

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 - Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL

NEW DUCT INSULATION CONDITION

UNIT CONST COST: \$3.05 / ft²

BLDG #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft ²)	R		R INS.	U	THERMAL COND. (Btu in/ h ft ² F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft ²)	TOTAL LEAK (cfm)	WINTER		SUMMER	
				OUTER FILM	INNER FILM									DUCT TEMP (F)	AMB TEMP (F)	DUCT TEMP (F)	AMB TEMP (F)
G101	80	45	300	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90
G735	80	25	167	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	25.5	90	75	55	90
	160	10	133	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	20.4	90	75	55	90
TOTAL																	

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL

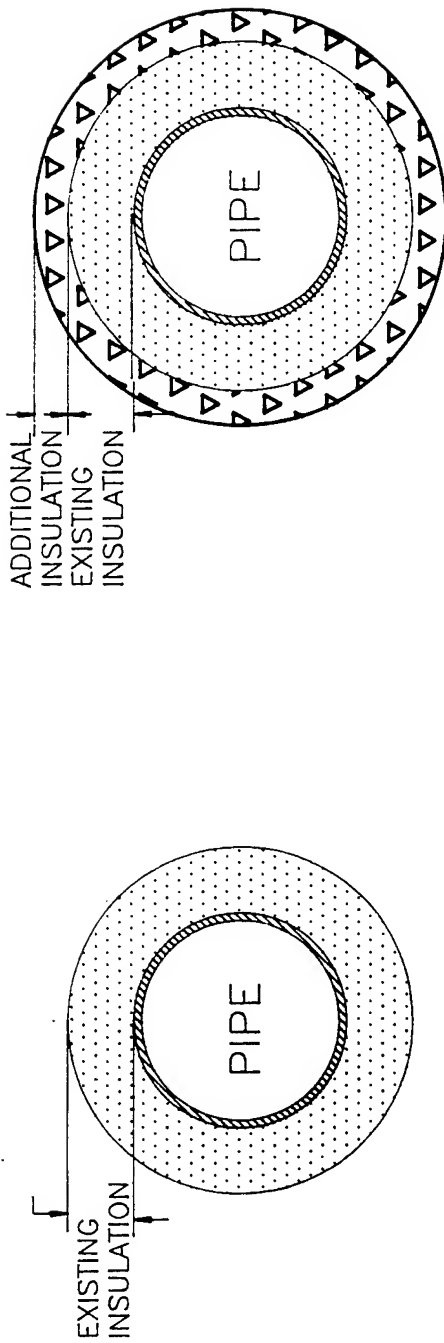
NEW DUCT INSULATION CONDITION

UNIT CONST \$3.05 / ft²

BLDG. #	IMPROVED ENERGY LOSSES				ANNUAL ENERGY SAVINGS			TOTAL CONST COST (\$)
	WINTER LEAK (Btu/h)	TOTAL (Btu/h)	INSUL (kW)	SUMMER LEAK (kW)	TOTAL (kW)	GAS (MBtu/yr)	ELECTRIC (kW/yr)	
G101	700.7	700.7	0.03	--	0.03	3.1	134.2	\$915.00
G735	389.3	950.1	0.02	0.10	0.12	4.2	531.5	\$508.33
	311.4	760.1	0.01	0.08	0.10	3.3	425.2	\$406.67
TOTAL						31.6	3770.2	\$915.00

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ADDITIONAL INSULATION

FLUID	PIPE SIZE (inches)				
	0.25- 1.00	1.25- 2.00	2.25- 3.00	3.25- 4.00	4.25- 5.00
CHILLED WATER PIPES					
Fiberglass	0.50	0.75	1.00	1.00	1.00
Rubber	1.00	1.00	1.00	1.00	1.00
Foam	1.50	1.50	1.50	2.00	2.00
HOT WATER PIPES (Also Condensate)					1.50
Fiberglass	1.50	1.50	1.50	1.50	1.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
STEAM PIPES					
Fiberglass	2.00	2.50	2.50	3.00	3.50
Rubber	1.50	1.50	1.50	2.50	2.50
Foam	1.50	1.50	1.50	2.50	2.50
DUCTS	All Sizes				
	2" Fiberglass				

APPENDIX C-2
INSULATED GLASS

INSULATED GLASS SAMPLE CALCULATION, ECO #2 BUILDING 505 (GILLEM)

Given:

# of Windows	= 127 windows	- from bldg plans / survey notes
Window Perimeter	= 3,387 ft	- from bldg plans / survey notes
Window Area	= 6,468 ft ²	- from bldg plans / survey notes
Gas Savings Factor	= 0.0031 MBtu / ft ²	- from Bldg 100 simulation
Electric Savings Factor	= 0.68 kWh / ft ²	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Peak Demand Savings:

$$(6,468 \text{ ft}^2) * (0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

- Gas:	$(6,468 \text{ ft}^2) * (0.031 \text{ MBtu} / \text{ft}^2)$	= 201 MBtu
- Electric:	$(6,468 \text{ ft}^2) * (0.68 \text{ kWh} / \text{ft}^2)$	= 4,398 kWh

Annual Cost Savings:

$$(201 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (4,398 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$1,049 / \text{yr}$$

Estimated Construction Cost:

\$19.37 / each window demolition	- from engineer's cost estimate
\$31.57 / ft of perimeter	- from engineer's cost estimate

$$(\$19.37 / \text{ea}) * (127 \text{ win}) + (\$31.57 / \text{ft}) * (3,387 \text{ ft}) = \$109,377$$

$$\$109,377 + (\$109,377 * .055 \text{ SIOH}) + (\$109,377 * .06 \text{ DESIGN}) = \$121,955$$

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 2 – Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 16-Jul-92

FILE: ECO-2.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
505	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
506	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
507	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
508	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
509	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
510	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
511	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
512	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
513	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
514	0	4,398	201	216	1,049	\$0	\$0	\$1,049	\$121,955	0.2	116
101	9	3,363	123	134	660	\$930	\$0	\$1,589	\$183,878	0.2	116
207	0	665	30	33	158	\$0	\$0	\$158	\$31,125	0.1	197
735	0	(9)	1	1	6	\$0	\$0	\$6	\$2,751	0.1	455

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 2 - Insulated Glass

EMC PROJECT: #3105.000
DATE: 15-APR-92

FILE: ECO-2.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	# WIN	WIN PERIM (ft)	WIN AREA (ft ^ 2)	DEMAND SAVINGS (kW/ft²)	ELECTRIC SAVINGS (kWh/ft²)	GAS SAVINGS (MBtu/ft²)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT DEMO COST (\$/ea)	UNIT CONST COST (\$/ft)	TOTAL CONST COST (\$)
101	231	5,082	6,468	0.0014	0.52	0.019	9.1	3,363	123	\$19.37	\$31.57	\$164,913
207	46	856	976	0	0.68	0.031	0	665	30	\$19.37	\$31.57	\$27,915
505	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
506	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
507	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
508	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
509	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
510	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
511	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
512	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
513	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
514	127	3,387	6,468	0	0.68	0.031	0	4,398	201	\$19.37	\$31.57	\$109,377
735	7	89	67	0	-0.13	0.020	0	(8.7)	1.3	\$11.83	\$26.89	\$2,467

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 2 – Insulated Glass

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 21-APR-92

FILE: EC0-2.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

BLDG #	# WIN	LENGTH (in)	WIDTH (in)	AREA (ft²)	PERIM (ft)	TOTAL AREA (ft²)	TOTAL PERIM (ft)	TOTAL # WIN
101	231	84	48	6468	5082	6468	5082	231
207	30	72	48	720	600	976	856	46
	16	48	48	256	256			
505	127	52	108	4953	3387	6468	3387	127
506	127	52	108	4953	3387	6468	3387	127
507	127	52	108	4953	3387	6468	3387	127
508	127	52	108	4953	3387	6468	3387	127
509	127	52	108	4953	3387	6468	3387	127
510	127	52	108	4953	3387	6468	3387	127
511	127	52	108	4953	3387	6468	3387	127
512	127	52	108	4953	3387	6468	3387	127
513	127	52	108	4953	3387	6468	3387	127
514	127	52	108	4953	3387	6468	3387	127
735	2	53	30	22	28	67	89	7
	3	54	30	34	42			
	2	30	27	11	19			

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

X CODE A CODE B CODE C

OTHER

EFFECTIVE PRICING

DATE APR 92

SHT OF

DATE PREPARED

15-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft. Gillem

CHECKED BY

SHIPPING

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APPENDIX C-3

WEATHERSTRIPPING AND CAULKING

WEATHERSTRIPPING & CAULKING SAMPLE CALCULATION, ECO #3 BUILDING 111

Given:

Stack coefficient(A)	= 0.016	-from ASHRAE Table F 23.7
Wind coefficient(B)	= 0.0039	-from ASHRAE Table F 23.7
Avg. temperature diff.	= 72 - 55 = 17°F	-from Atlanta weather data
Avg. wind speed	= 12.65 mph	-from Atlanta weather data
# of windows	= 24 windows	-from bldg plans / survey notes
Window area	= 380 ft ²	-from bldg plans / survey notes
Exist. window leakage coef.	= 0.052 in ² /ft ²	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	= 0.093 in ² /ft ²	-from ASHRAE Table F 23.3
Imp. window leakage coef.	= 0.026 in ² /ft ²	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.019 in ² /ft ²	-from ASHRAE Table F 23.3
# of doors	= 3 doors	-from bldg plans / survey notes
Door area	= 52 ft ²	-from bldg plans / survey notes
Exist. door leakage coef.	= 0.157 in ² /ft ²	-from ASHRAE Table F 23.3
Exist. frame leakage coef.	= 0.072 in ² /ft ²	-from ASHRAE Table F 23.3
Imprv. door leakage coef.	= 0.114 in ² /ft ²	-from ASHRAE Table F 23.3
Imprv. frame leakage coef.	= 0.0143 in ² /ft ²	-from ASHRAE Table F 23.3
Total door/win perimeter	= 440 ft	-from bldg plans / survey notes
Gas savings factor	= 0.025 MBtu/cfm	-from Bldg 100 simulation
Electric savings factor	= 5.8 kWh/cfm	-from Bldg 100 simulation
Demand savings factor	= 0.0 kW/cfm	-from Bldg 100 simulation
Gas Cost	= \$4.67/MBtu	-from utility rate analysis
Electric Cost	= \$0.0255/kWh	-from utility rate analysis
Demand Cost	= \$8.85/kW	-from utility rate analysis

Existing Effective Leakage Area:

$$(.052 + .093 \text{ in}^2/\text{ft}^2) * (380 \text{ ft}^2) + (.157 + .072 \text{ in}^2/\text{ft}^2) * (52 \text{ ft}^2) \\ = 66.9 \text{ in}^2$$

Existing Window / Door Infiltration:

$$66.9 * (0.016 * (17) + .0039 * (12.65^2))^{1/2} = 63 \text{ cfm}$$

Improved Effective Leakage Area:

$$(.026 + .019 \text{ in}^2/\text{ft}^2) * (380 \text{ ft}^2) + (.114 + .0143 \text{ in}^2/\text{ft}^2) * (52 \text{ ft}^2) \\ = 23.7 \text{ in}^2$$

Improved Window / Door Infiltration:

$$23.7 * (0.016 * (17) + .0039 * (12.65^2))^{1/2} = 22 \text{ cfm}$$

Delta infiltration:

$$63 - 22 = 41 \text{ cfm}$$

Peak Demand Savings:

$$(41 \text{ cfm}) * (0.0 \text{ kW} / \text{cfm}) = 0.0 \text{ kW}$$

Annual Energy Savings:

$$\begin{aligned} \text{- Gas:} & \quad (41 \text{ cfm}) * (0.025 \text{ MBtu} / \text{cfm}) = 1.02 \text{ MBtu} \\ \text{- Electric:} & \quad (41 \text{ cfm}) * (5.8 \text{ kWh} / \text{cfm}) = 187 \text{ kWh} \end{aligned}$$

Annual Cost Savings:

$$(1.02 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (187 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + 0.95 * 8) = \$10 / \text{yr}$$

Estimated Construction Cost:

\$53.00 / window	-from engineer's cost estimate
\$114.17 / door	-from engineer's cost estimate
\$1.18 / ft of perimeter	-from engineer's cost estimate

$$(\$53.00 / \text{ea}) * (24 \text{ win}) + (\$114.17 / \text{ea}) * (3 \text{ doors}) + (\$1.18 / \text{ft}) * (440 \text{ ft}) = \$2,133$$

$$\$2,133 + (\$2,133 * .055 \text{ SIOH}) + (\$2,133 * .06 \text{ DESIGN}) = \$2,378$$

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 3 – Weatherstripping & Caulking

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE:
FILE: ECO-3.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	2	669	19	21	\$105	\$208	\$0	\$313	\$21,926	0.2	70
207	0	178	7	8	\$38	\$0	\$0	\$38	\$13,756	0.1	360
505	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
506	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
507	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
508	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
509	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
510	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
511	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
512	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
513	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
514	0	307	13	14	\$66	\$0	\$0	\$66	\$20,750	0.1	313
735	0	10	0	0	\$2	\$3	\$0	\$5	\$1,474	0.1	310

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 3 - Weatherstripping & Caulking

EMC PROJECT: #3105.000

DATE: 15-APR-92

FILE: ECO-3.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	TOTAL PERIM (ft)	# WIN	# DOORS	OH DOORS PERIM (ft)	DELTA INFIL (cfm)	DEMAND SAVINGS (kW/cfm)	ELECTRIC SAVINGS (kWh/cfm)	GAS SAVINGS (MBtu/cfm)	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST (\$/ft)	UNIT CONST COST (\$/win)	UNIT CONST COST (\$/door)	UNIT CONST COST (\$/ft oh d)	CONST COST (\$)
101	5322	231	10	0	752	0.0027	0.89	0.025	2.03	669	18.8	\$1.18	\$53.00	\$114.17	\$8.34	\$19,665
207	1600	92	12	504	660	0	0.27	0.011	0	178	7.2	\$1.18	\$53.00	\$114.17	\$8.34	\$12,337
505	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
506	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
507	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
508	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
509	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
510	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
511	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
512	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
513	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
514	4305	128	10	672	1137	0	0.27	0.011	0	307	12.5	\$1.18	\$53.00	\$114.17	\$8.34	\$18,610
735	225	7	6	0	11	0.0027	0.89	0.025	0.03	10	0.3	\$1.18	\$53.00	\$114.17	\$8.34	\$1,322

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 3 - Weatherstripping & Caulking
 CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE: 15-APR-92
 FILE: ECO-3.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

BLDG #	# STORIES	A	B	WALL CONST.	# WIN.	GLASS TYPE	WIN TYPE	INFIL DESCRIP	WIN (in ² /ft ²)	FRAME (in ² /ft ²)	L (in)	W (in)	WIN PERIM (ft)	WIN AREA (ft ²)	L off (in ²)	# DOORS	INFIL DESCRIP	DOOR (in ² /ft ²)	FRAME (in ² /ft ²)	L (in)	W (in)
101																					
207																					
505																					
506																					
507																					
508																					
509																					
510																					
511																					
512																					
513																					
514																					
735	1	0.016	0.004	Frame	2	Si	Si	Low	0.026	0.004	53	30	28	22	1	3	Med	0.157	0.024	80	64
					3	Si	Si	Low	0.026	0.004	54	30	42	34	1	2	High	0.157	0.024	80	64
					2	Si	Si	Low	0.026	0.004	30	27	19	11	0	1	Med	0.157	0.024	70	30

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 3 - Weatherstripping & Caulking

EMC PROJECT: #3105.000
 DATE: 15-APR-92
 FILE: ECO-3.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	DOOR PERIM (FT)	DOOR AREA (ft²)	L off (in²)	TOTAL L off (in²)	IMPRV WIN (in²/ft²)	IMPRV FRAME (in²/ft²)	IMPRV DOOR (in²/ft²)	IMPRV FRAME (in²/ft²)	IMPRV L off (in²)	EXIST INFIL (cfm)	IMPRV INFIL (cfm)	DELTA INFIL (cfm)	TOTAL PERIM (ft)	# WIN	# DOORS	OH DOORS PERIM (ft)
101										11989	11237	752	5322	231	10	
207												660	1600	92	12	504
505												1137	4305	128	10	672
506												1137	4305	128	10	672
507												1137	4305	128	10	672
508												1137	4305	128	10	672
509												1137	4305	128	10	672
510												1137	4305	128	10	672
511												1137	4305	128	10	672
512												1137	4305	128	10	672
513												1137	4305	128	10	672
514												1137	4305	128	10	672
735	72	107	19	36.8	0.026	0.004	0.114	0.004	24.7	35	23	11	225	7	6	
	48	71	13													
	17	15	3													

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐
☐ OTHER _____

EFFECTIVE PRICING

DATE APR 92

DRAWING NO.

DATE PREPARED

15-Apr-92

SHT OF

CHECKED BY

ESTIMATOR RMG

TASK DESCRIPTION	Quantity No. Of Units	LABOR			EQUIPMENT		MATERIAL		TOTAL		SHIPPING	
		MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Unit Price	Cost	Cost	Unit Wt	Unit Wt	Total Wt
ECO 3 - Weatherstripping & Caulking												
TASK DESCRIPTION												
ASTRAGAL, OVERHEAD DOOR	1 LF	0.178	0.178	\$18.53	\$3.30		\$2.50	\$2.50	\$5.80			
SUBTOTAL					\$3.30				\$5.80			
OVERHEAD, BOND	15%				\$0.49				\$0.87			
PROFIT	10%				\$0.33				\$0.58			
COST SUB-TOTAL					\$4.12				\$7.25			
CONTINGENCY	15%				\$0.62				\$1.09			
TOTAL					\$4.74				\$8.34			
WEATHERSTRIPPING, WINDOW	1 EA	1.110	1.110	\$18.53	\$20.57		\$16.30	\$16.30	\$36.87			
SUBTOTAL					\$20.57				\$36.87			
OVERHEAD, BOND	15%				\$3.09				\$5.53			
PROFIT	10%				\$2.06				\$3.69			
COST SUB-TOTAL					\$25.71				\$46.09			
CONTINGENCY	15%				\$3.86				\$6.91			
TOTAL					\$29.57				\$53.00			
WEATHERSTRIPPING, DOOR	1 EA	2.7	2.667	\$18.53	\$49.42		\$30.00	\$30.00	\$79.42			
SUBTOTAL					\$49.42				\$79.42			
OVERHEAD, BOND	15%				\$7.41				\$11.91			
PROFIT	10%				\$4.94				\$7.94			
COST SUB-TOTAL					\$61.77				\$99.27			
CONTINGENCY	15%				\$9.27				\$14.89			
TOTAL					\$71.04				\$114.17			
CAULKING, SILICONE	1 LF	0.031	0.031	\$19	\$0.57		\$0.25	\$0.25	\$0.82			
SUBTOTAL					\$0.57				\$0.82			
OVERHEAD, BOND	15%				\$0.09				\$0.12			
PROFIT	10%				\$0.06				\$0.08			
COST SUB-TOTAL					\$0.72				\$1.02			
CONTINGENCY	15%				\$0.11				\$0.15			
TOTAL					\$0.83				\$1.18			

JOB #3105.000 FT. MCPHERSON/GILLEM

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

SHEET NO. _____ OF _____

CALCULATED BY CEL DATE 7/20/92

CHECKED BY _____ DATE _____

SCALE NONE

Weatherstripping cost estimates taken from MEANS BUILDING CONSTRUCTION
COST DATA 1992

Overhead doors:

- Interlocking aluminum, 5/8" x 1" neoprene bulb insert.

Windows:

- Bronze weatherstripping for 3' x 5' double hung window.

Personnel doors:

- Metal frame, bronze weatherstripping, spring type.

APPENDIX C-4

MEASURE HOT WATER TEMPERATURES

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 4 - Domestic Hot Water Temperatures

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 15-APR-92

FILE: ECO-4.WK3

PREPARED BY: CHRIS STANLEY

CHECKED BY:

BLDG #	BLDG DESCRIPTION	LOCATION OF BLDG.	HOT WTR TEMP (°F)
101	ADMINISTRATION	Mech Room, Basement, W	150
		Men's Bathroom, Flr 1, W	141
102	MAINTENANCE	Men's Bathroom, S	128
		Woodshop Sink	138
103	FIRE STATION	AHU Room Sink	133
		Bathroom	134
133	OFFICERS CLUB	Men's Bathroom, N.E.	155
		Kitchen	152
207	STORAGE	Faucet, Bay 1	142
		Men's Bathroom, Bay 3	142
		Break Room	125
213	CID BUILDING	Men's Bathroom, Bay 5	122
214	COMMISSARY	Men's Bathroom, S	139
		Break Room, Middle of Bldg	130
		Vegetable Cleaning Room	146
308	STORAGE	Men's Bathroom, N	140
		Men's Bathroom, S.E.	131
400	DOL	Men's SHOWER, N.E.	96
		Paint Room, Sink	92
		Sink, SW	104
		Sink, SE	110
401	EIGHTY-FIRST	Bathroom, Downstairs	N/A
		Showers, Upstairs	108
403	DINING FACILITY	Men's Bathroom, SW	120
		NW Mess Hall	136
		Bathroom, N	156
505	STORAGE	Women's Bathroom, E	144
		Men's Bathroom, E	151
512	STORAGE	Men's Bathroom, W, Bay 2	101
		Break Room, NW, Bay 1	129
513	STORAGE	Women's Bathroom, E	144
		Men's Bathroom, E	151
735	THEATER (T)	Men's Bathroom	155
		Women's Bathroom	155
935	FITNESS CENTER	Men's Locker Room	129

APPENDIX C-5
ELECTRIC MOTORS

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25
LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-5 HIGH EFFICIENCY MOTOR

ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 33322.
B. SIOH	\$ 1833.
C. DESIGN COST	\$ 2000.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 37155.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	243.	\$ 1816.	15.61	28341.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		243.	\$ 1816.		\$ 28341.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$ 1102.
(1) DISCOUNT FACTOR (TABLE A)	14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$ 16012.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$ 16012.
D. PROJECT NON ENERGY QUALIFICATION TEST	
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$ 9352.
A IF 3D1 IS = OR > 3C GO TO ITEM 4	
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E	1.01
C IF 3D1B IS = > 1 GO TO ITEM 4	
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY	

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))	\$ 2918.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	\$ 44353.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)=	1.19
(IF < 1 PROJECT DOES NOT QUALIFY)	
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4	12.73

**HIGH-EFFICIENCY MOTOR REPLACEMENT SAMPLE CALCULATION, ECO #5
BUILDING 40**

Given:

Motor Horsepower	= 3 hp	-from field survey
Operation Hours	= 8,760 hrs / yr	-from field survey
Standard Motor Efficiency	= 84%	-from standard motor info
High Eff Motor Efficiency	= 88.5%	-from high efficiency motor info
Motor Load Factor	= 85%	-assumed
Gas Cost	= \$4.67 / MBtu	-from utility rate analysis
Electric Cost	= \$0.0255 / kWh	-from utility rate analysis
Demand Cost	= \$8.85 / kW	-from utility rate analysis

Existing Demand:

$$\frac{(3 \text{ hp}) * (0.746 \text{ kw / hp}) * (85\%)}{(84\%)} = 2.26 \text{ kw}$$

Improved Demand:

$$\frac{(3 \text{ hp}) * (0.746 \text{ kw / hp}) * (85\%)}{(88.5\%)} = 2.15 \text{ kw}$$

Peak Demand Savings:

$$2.26 \text{ kW} - 2.15 \text{ kW} = 0.11 \text{ kW}$$

Annual Electric Savings:

$$(0.11 \text{ kW}) * (8,760 \text{ hrs / yr}) = 964 \text{ kWh / yr}$$

Annual Cost Savings:

$$(0.0 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (964 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.11 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + 0.95 * 8) = \$36 / \text{yr}$$

Estimated Construction Cost:

$$\$624 / 3 \text{ hp motor} \quad \text{-from engineer's cost estimate}$$

$$\$624 + (\$624 * .055 \text{ SIOH}) + (\$624 * .06 \text{ DESIGN}) = \$695$$

EMC ENGINEERS, INC.

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 17-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	4	25,493	0	87	\$650	\$455	\$0	\$1,106	\$10,132	1.7	9.2
214	1	10,031	0	34	\$256	\$141	\$0	\$397	\$5,601	1.1	14.1
213	4	26,425	0	90	\$674	\$397	\$0	\$1,071	\$16,122	1.0	15.1
207	1	5,364	0	18	\$137	\$63	\$0	\$200	\$3,041	1.0	15.2
103	0	3,912	0	13	\$100	\$46	\$0	\$146	\$2,259	1.0	15.5
TOTAL	11	71,225	0	243	\$1,816	\$1,102	\$0	\$2,918	\$37,154	1.2	12.7
512	0	2,461	0	8	\$63	\$29	\$0	\$92	\$1,477	0.9	16.1
133	0	3,206	0	11	\$82	\$38	\$0	\$119	\$2,025	0.9	17.0
400	1	6,557	0	22	\$167	\$146	\$0	\$313	\$5,704	0.8	18.2
308	0	4,070	0	14	\$104	\$48	\$0	\$151	\$2,770	0.8	18.3
102	0	1,585	0	5	\$40	\$19	\$0	\$59	\$1,153	0.8	19.6
935	1	4,171	0	14	\$106	\$72	\$0	\$178	\$3,578	0.8	20.1
735	0	727	0	2	\$19	\$34	\$0	\$53	\$1,324	0.6	25.2

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 – Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 15-Jul-92

FILE: ECO-5.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER/ UNDER SIZED	NAMEPLATE			MEASURED			LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
				HP	FLA	VOLTS	EFF	AMPS	PF	VOLTS					
101	HWP 1	Off	OVER OVER	30.0	85.0	200		90.6	0.84	203	85%	90.2%	93.6%	4380	3,355
	HWP 2			30.0	85.0	200					85%	90.2%	93.6%		
	CWP 1			10.0	29.0	208		16.0	0.75	205	85%	87.5%	91.7%	4380	1,454
	CWP 2			10.0	29.0	208		16.7	0.72	204	85%	87.5%	91.7%	4380	1,454
	AHU 1			2.0	6.0	208	82.5%				85%	82.5%	86.5%	8760	623
	AHU 2			7.5	24.4	200					85%	86.5%	91.7%	8760	2,731
	AHU 3			5.0	15	208	62.5%				85%	62.5%	89.5%	8760	13,406
	AHU 1 FLR 4			2.0	6	208	82.5%				85%	82.5%	86.5%	8760	623
	AHU 3 FLR 4			5.0	15	200					85%	85.5%	89.5%	8760	1,452
	AHU 4			1.0	3.8	200					85%	77.0%	86.5%	4380	396
102	TOTAL			102.5											25,493
	AHU 1			1.0	3.0	208					85%	77.0%	86.5%	8760	792
	AHU 2			1.0	3.0	208					85%	77.0%	86.5%	8760	792
103	TOTAL			2.0											1,585
	AHU 1			3.0	9.6	200		9.6	0.80	200	85%	84.0%	88.5%	8760	1,009
	ROOF AHU 1	No Accel		5.0							85%	85.5%	89.5%	8760	1,452
	ROOF AHU 2	No Accel		5.0							85%	85.5%	89.5%	8760	1,452
	TOTAL			13.0											3,912
133	AHU 1			3.0	11.4	200					85%	84.0%	88.5%	8760	1,009
	AHU 2			3.0	11.4	200					85%	84.0%	88.5%	8760	1,009
	AHU 3			1.5	8.0	230					85%	77.0%	86.5%	8760	1,188
	TOTAL			7.5											3,206
207	AHU 1			3.0	9.6	200					85%	84.0%	88.5%	8760	1,009
	AHU 2			5.0	14.8	200	0.855				85%	85.5%	89.5%	8760	1,452
	AHU 3			5.0	14	208					85%	85.5%	89.5%	8760	1,452
	AHU 4			5	14.2	208					85%	85.5%	89.5%	8760	1,452
	TOTAL			18.0											5,364

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 5 - Install High Efficiency Electric Motors

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE			MEASURED			LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
				HP	FLA	VOLTS	EFF	AMPS	PF	VOLTS					
213	AHU 1A		OVER	3.0	9	200					85%	84.0%	88.5%	8760	1,009
	AHU 2B			15.0	49	200	0.875	27.7	0.81	208	85%	87.5%	92.4%	8760	5,050
	AHU 3B			2.0	6.6	200					85%	80.0%	86.5%	8760	1,044
	AHU 1			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	AHU 2			7.5	21	230					85%	86.5%	91.7%	8760	2,731
	AHU 3			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	AHU 4			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	AHU 5			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	AHU 6			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	AHU 7			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	AHU 8			5	14.4	230					85%	85.5%	89.5%	8760	1,452
	CWP 1			10	26.6	208	0.865				85%	86.5%	91.7%	4380	1,821
	CWP 2			10	26.6	208	0.865				85%	86.5%	86.5%	4380	522
	CWP 3			2	7	208					85%	80.0%	86.5%	4380	396
214	FWP 3		Off	1	3.75	208					85%	77.0%	86.5%	4380	1,366
	FWP 1			7.5	21	230					85%	86.5%	91.7%	4380	
	FWP 2			7.5	21	230					85%	88.5%	88.5%	2190	252
	COND PUMP 1			3	9	200					85%	84.0%	88.5%	2190	252
308	COND PUMP 2			3.0	9	200									
	TOTAL			106.5											26,425
	FWP			15.0	19.6	460		16	0.81	472	85%	88.5%	92.4%	4380	1,987
	AHU		OVER	40.0	49	460		25.9	0.70	474	85%	91.0%	94.1%	8760	8,044
400	TOTAL			55.0											10,031
	AHU 1			3.0	9.6	200					85%	84.0%	88.5%	8760	1,009
	AHU 2			2.0	6.2	230					85%	80.0%	86.5%	8760	1,044
	COND. PUMP 1			3.0	8.2	208					85%	84.0%	88.5%	8760	1,009
400	COND. PUMP 2			3.0	8.2	208					85%	84.0%	88.5%	8760	1,009
	TOTAL			11.0											4,070
	CIRC. FAN 1			3.0	8.4	220					85%	84.0%	88.5%	2190	252
	CIRC. FAN 2	Off		3.0	8.4	220					85%	84.0%	88.5%	2190	252
400	AHU 1			10	26	200		21		206	85%	87.5%	91.7%	8760	2,908
	AHU 2			5	9	200	0.84				85%	84.0%	89.5%	8760	2,032
	COND. PUMP 1			7.5	21	200					85%	86.5%	91.7%	2190	683
	COND. PUMP 2			7.5	21	200					85%	86.5%	91.7%	2190	683
TOTAL				36.0										1.4	6,557

E M C ENGINEERS, INC.

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE			MEASURED			LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
				HP	FLA	VOLTS	EFF	AMPS	PF	VOLTS					
512	AHU 1			5.0	14.8	200				85%	85.5%	89.5%	0.17	8760	1,452
	AHU 2			3.0	7.6	208				85%	84.0%	88.5%	0.12	8760	1,009
	TOTAL			8.0											
735	AHU 1		OVER	10	30	200		23	0.76	204	85%	87.5%	91.7%	2190	2,461
	TOTAL			10.0									0.3		727
935	HWP 1			5.0	12.8	230				85%	85.5%	89.5%	0.17	4380	726
	HWP 2			3.0	9	200				85%	84.0%	88.5%	0.12	8760	1,009
	AHU 1			2.0	6.1	208				85%	80.0%	86.5%	0.12	4380	522
	AHU 4			1.5	4.8	208				85%	77.0%	86.5%	0.14	8760	1,188
	AHU 5			5.0	14.7	208				85%	85.5%	89.5%	0.17	4380	726
TOTAL				16.5									0.7		4,171

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL (\$)	OH&B 15%	PROFIT 10%	SUB TOTAL (\$)	CONT 15%	TOTAL (\$)
		MOTOR (\$)	LABOR (\$)						
101	HWP 1	\$1,639	\$152	\$1,791	\$269	\$179	\$2,239	\$336	\$2,575
	HWP 2								
	CWP 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	CWP 2	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	AHU1	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 2	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	AHU 3	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 1 FLR 4	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 3 FLR 4	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 4	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
	TOTAL								\$9,087
102	AHU 1	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
	AHU 2	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
	TOTAL								\$1,035
103	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	ROOF AHU 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	ROOF AHU 2	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	TOTAL								\$2,026
133	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 3	\$328	\$68	\$396	\$59	\$40	\$495	\$74	\$569
	TOTAL								\$1,816
207	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 3	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 4	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	TOTAL								\$2,727

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL (\$)	OH&B 15%	PROFIT 10%	SUB TOTAL (\$)	CONT 15%	TOTAL (\$)
		MOTOR (\$)	LABOR (\$)						
213	AHU 1A	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2B	\$985	\$114	\$1,099	\$165	\$110	\$1,374	\$206	\$1,580
	AHU 3B	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 2	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	AHU 3	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 4	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 5	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 6	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 7	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 8	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	CWP 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	CWP 2	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	CWP 3	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
214	FWP 3	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
	FWP 1	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	FWP2								
	COND PUMP 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
214	COND PUMP 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	TOTAL								\$14,459
214	FWP	\$985	\$114	\$1,099	\$165	\$110	\$1,374	\$206	\$1,580
	AHU	\$2,212	\$183	\$2,395	\$359	\$239	\$2,994	\$449	\$3,443
308	TOTAL								\$5,023
	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	COND. PUMP 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	COND. PUMP 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
400	TOTAL								\$2,484
	CIRC. FAN 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	CIRC. FAN 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	AHU 2	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	COND. PUMP 1	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	COND. PUMP 2	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	TOTAL								\$5,115

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92

FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL (\$)	OH&B 15%	PROFIT 10%	SUB TOTAL (\$)	CONT 15%	TOTAL (\$)
		MOTOR (\$)	LABOR (\$)						
512	AHU 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	TOTAL								\$1,325
735	AHU 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	TOTAL								\$1,188
935	HWP 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	HWP 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 1	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 4	\$328	\$68	\$396	\$59	\$40	\$495	\$74	\$569
	AHU 5	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	TOTAL								\$3,209

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB FT. MCPHERSON/GILLEM ESOS STUDY

SHEET NO EMC #3105.000 OF

CALCULATED BY CEL DATE 7/22/92

CHECKED BY DATE

SCALE

RESEARCH OF PREMIUM EFFICIENCY MOTORS WITH SPEED CONTROLS:

A number of good articles on energy efficient motors and motor controls were reviewed. A list of these articles is provided below.

In regards to the question of, "Should energy efficient motors be used with variable speed controls?", one article stated:

"When using adjustable-speed drives, it is best to specify the highest-efficiency motor possible. Inverters deliver a waveform that is less than an ideal pure sine wave. This chopped waveform causes more heating and losses in the motor. A motor with less losses can tolerate more impurities in input power without overheating. Heat is the ultimate enemy of motors, reducing life expectancy. For every 10oC higher running temperature, the life of the motor is cut in half. Premium-efficiency motors also run quieter and give a wider full-load speed range than normal motors operating on an adjustable-speed drive." *Energy Efficiency In Electric Motors*, Darryl VanSon, Consulting/Specifying Engineer, November 1989.

In regards to the question of, "Is the improved efficiency due to the frequency of the motor or some other factors?", see is the attached article from General Electric, describing motor losses, construction of high-efficiency motors, and motor standards.

ARTICLES:

How to Select, Apply, and Install, Modern Motors and Controllers, Robert Lawrie, EC&M, June 1991.

Variable-Frequency Drives Take Hold In HVAC Market, Paul Beck, Consulting/Specifying Engineer, September 1991.

Applying AC Adjustable Frequency Drives to HVAC Systems, Kenneth A. Fanstad, Consulting Specifying Engineer, May 1989.

Energy Efficiency In Electric Motors, Darryl VanSon, Consulting/Specifying Engineer, November 1989.

Motor Selection Based Only On Purchase Price Can Be A Costly Mistake

Energy efficient motors represent an investment of 20 to 25% over the cost of standard, normal efficiency motors. While this premium can be recovered in a short period of time, the first objective should be to maximize the return on investment. To reach this goal, the motor user needs to understand motor efficiency, how it is achieved and how to conduct an economic evaluation. It is vital to evaluate the differences between motors offered by various manufacturers and only choose motors which clearly meet the user's operating criteria and cost reduction goals.

Understanding Motor Losses

Motor efficiency, as shown in Figure 1, is the watts output divided by the watts input. This is better expressed as the watts input minus the losses divided by the watts input.

$$\begin{aligned}\text{Efficiency} &= \frac{746 \times \text{Hp Output}}{\text{Watts Input}} \\ &= \frac{\text{Input} - \text{Losses}}{\text{Input}}\end{aligned}$$

Figure 1. Efficiency Equation

The only way to improve efficiency is to reduce motor losses. The components of motor losses can be broadly defined as no-load losses and load losses as shown in Figure 2.

No Load Losses	% Total
• Windage, Friction	14
• Core Losses	16
Load Losses	
• Stator I ² R Losses	33
• Rotor I ² R Losses	15
• Stray Load Losses	22
Total	100

Figure 2. Distribution of Losses

No load losses account for 30% of the total losses and include windage and friction losses plus core losses. The windage and friction losses are mechanical losses from bearing friction plus fan and rotor windage. Core losses are a combination of hysteresis and eddy current losses in the magnetic steel core.

Load losses account for the remaining 70% of the total losses and include stator and rotor I²R losses and stray load losses. Stator losses are the product of stator input current (at load) squared and the stator resistance at operating temperature. Rotor losses result from rotor currents and are the product of the induced rotor current squared and the rotor resistance at operating temperature. Motor slip is a result of rotor losses.

Stray load losses are a result of additional harmonic and circulating current losses in the magnetic steel and windings. These losses are a result of design and manufacturing processes. Some of the factors which contribute to stray load losses are shown in Figure 3.

- Number of Slots
- Stator and Rotor Slot Geometry
- Rotor Slot Insulation
- Air Gap Length
- Manufacturing Process Control

Figure 3. Stray Load Loss Factors

Improving Efficiency Takes Know-how

The energy efficient motor design engineer strives for design optimization using techniques shown in Figure 4.

Most motors available today use a low carbon lamination steel for rotor and stator construction. This steel typically has 3.0 watts-per-pound of electrical losses and costs approximately the same as cold rolled steel. To reduce hysteresis and eddy current losses, manufacturers build energy efficient motors with high grade silicon steel. This steel has an electrical loss of 1.5 watts-per-pound and costs approximately 50% more than standard motor lamination steel.

- Improved Steel Properties
- Thinner Laminations
- Increased Wire Volume
- Improved Slot Designs
- More Steel
- Improved Rotor Insulation System
- More Efficient Fan Design

Figure 4. Efficiency Improvement

To further reduce eddy current losses, the high grade silicon steel is purchased in a thinner gauge than the low carbon lamination steel. Typical lamination thickness is .018 and .022 inches for the silicon and low carbon steel, respectively. In addition, the silicon steel has a surface coat of insulation to provide high inter-lamination resistance to eddy currents.

By increasing the volume of copper wire by 35 to 40%, the stator I^2R losses can be reduced. To accommodate this increase, slot areas must also be increased by as much as 50%. To compensate for the increase in slot size and corresponding decrease in active steel, the motor's rotor and stator core are lengthened. In addition to minimizing losses, this also reduces flux density and improves motor power factor. Nice additional benefits.

Rotor I^2R losses are improved through redesign of the rotor slots to increase the conductor cross section. In doing so, the rotor full load speed is increased slightly. The slot redesign must be made in such a way to continue to provide NEMA design B torques and locked rotor currents. This requires careful selection of the slot shape as well as the slot size.

Some of the losses in the motor are due to unplanned conduction paths which result from normal manufacturing processes. One such path is along the rotor surface where the rotor OD is turned down to provide a uniform air gap. Careful choice and control of the process are required to keep losses at a minimum.

Another such path is the current flow between rotor bars where the rotor is skewed. Skewing is a normal practice in small motors to reduce noise and torque pulsations. To minimize losses from inter-bar currents, the raw punched

edges of the rotor slots are treated with a high temperature inorganic insulation before casting.

Because of the lower electromagnetic losses in an energy efficient motor, the motor does not require the same cooling as a standard motor design. This allows the designer to use a smaller fan to reduce windage and friction losses while achieving quieter operation.

In summary, by optimizing the design, motor losses are decreased and efficiency improvements are gained. As market conditions dictate and materials and technologies improve, further efficiency gains will be achieved.

Making The Standards Work For You

NEMA has adopted an efficiency labeling standard based upon probabilities (MG 1-12.54.2) which will help the buyer get what he is paying for. The bell-shaped curve shown in Figure 5, assumes that, once the nominal value of efficiency is defined for a specific motor design, half of the motors will be above that value and half below.

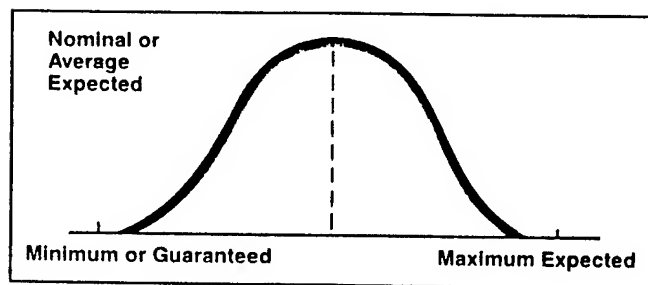


Figure 5. Motor Efficiency

The standard, which applies to NEMA designs A and B, single speed, polyphase, squirrel-cage, integral-Hp motors in the 1 through 125 horsepower sizes, calls for the nominal efficiency to be identified on the motor nameplate. This standard recognizes that variations in materials, manufacturing processes and test results cause motor to motor efficiency variations for a given design. Therefore, the full-load efficiency for a large population of motors of a given design is not a unique value but rather a band of efficiencies. The standard defines the minimum and nominal efficiency to expect from a motor design for a population of motors and

the manufacturer must select from the values in Figure 6. GE motors exceed these standards.

Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
98.0	97.6	87.5	85.5
97.8	97.4	86.5	84.0
97.6	97.1	85.5	82.5
97.4	96.8	84.0	81.5
97.1	96.5	82.5	80.0
96.8	96.2	81.5	78.5
96.5	95.8	80.0	77.0
96.2	95.4	78.5	75.5
95.8	95.0	77.0	74.0
95.4	94.5	75.5	72.0
95.0	94.1	74.0	70.0
94.5	93.6	72.0	68.0
94.1	93.0	70.0	66.0
93.6	92.4	68.0	64.0
93.0	91.7	66.0	62.0
92.4	91.0	64.0	59.5
91.7	90.2	62.0	57.5
91.0	89.5	59.5	55.0
90.2	88.5	57.5	52.5
89.5	87.5	55.0	50.5
88.5	86.5	52.5	48.0
		50.5	46.0

Figure 6. NEMA Efficiency Marking Standard

This standard establishes the nominal efficiency values that are to be used on the motor nameplate, the motor manufacturer selects the value range for a given design from the table.

NEMA standard MG 1-12.55 specifies efficiency levels for polyphase squirrel-cage induction motors to be classified as energy efficient. The nominal full-load efficiency as determined in accordance with MG 1-12.54.1 (IEEE test procedure 112, method B) and identified on the nameplate in accordance to the labeling standard MG 1-12.54.2, must equal or exceed the values shown in appendix "A" for the motor to be classified as energy efficient.

Specifying Guaranteed Values Is Best

Buyers who only specify the nominal efficiency value for new energy efficient motor purchases are relying on the manufacturer to consistently provide motors within the band

defined in the NEMA standards. By specifying and evaluating motors at the guaranteed minimum efficiency, the buyer can feel confident that his economic evaluation is conservative but reasonable. The buyer also has a basis to reject any motor which does not meet the guarantee.

The motor user who specifies and evaluates on guaranteed minimum efficiency values will discourage casual efficiency claims and can select a motor supplier with confidence.

The Energy Efficient Motor Decision

Specification and installation of energy efficient motors can yield attractive economic results compared to standard efficiency designs for the same installation.

To fully understand these benefits, the buyer can make either a simple payback calculation or a comprehensive economic evaluation including a life cycle cost analysis. Typically, as the quantity of motors increases and the value of the installation grows, a more detailed analysis is performed.

How To Calculate Annual Savings

In comparing the efficiencies of two motors, the buyer must consider the type of motors involved, the annual hours of operation, motor load, electrical costs and the motor efficiencies. These basic data apply whether the comparison is between a standard and an energy efficient design or between two energy efficient designs with different efficiencies. Regardless of the comparison, it is essential that the efficiency values be on the same basis — you must compare nominal vs. nominal or guaranteed vs. guaranteed.

With that in mind, the equation in Figure 7 can be used to determine annual savings for two 50 horsepower, 1800 rpm, totally-enclosed, fan-cooled, severe-duty motors operating at rated load. The nominal efficiency value for the standard efficiency motor is 91.7 while the comparable value for the energy efficient motor is 94.1. If operated continuously (8760 hours) with an electrical cost of \$.0512/kWh, the annual savings would be \$465.

INSTALL HIGH EFFICIENCY MOTORS

MOTORS OPERATING AT FULL LOAD (1800 RPM)					ELEC. COST: \$0.0255 /kWH DEMAND COST: \$8.85 /kW				
					HOURS OF OPERATION PER YEAR				
H.P.	STANDARD EFFICIENCY	PREMIUM EFFICIENCY	DIFFERENTIAL COST *	2000 HRS SAVINGS/ YEAR	SIMPLE PAYBACK	4000 HRS SAVINGS/ YEAR	SIMPLE PAYBACK	8760 HRS SAVINGS/ YEAR	SIMPLE PAYBACK
1	77.0%	86.5%	\$148	\$14	10.6	\$19	8.0	\$29	5.0
1.5	77.0%	86.5%	\$167	\$21	8.0	\$28	6.0	\$44	3.8
2	80.0%	86.5%	\$178	\$18	9.7	\$24	7.3	\$39	4.6
3	84.0%	88.5%	\$172	\$18	9.7	\$24	7.3	\$38	4.6
5	85.5%	89.5%	\$201	\$25	7.9	\$34	5.9	\$54	3.7
7.5	86.5%	91.7%	\$305	\$48	6.4	\$64	4.8	\$102	3.0
10	87.5%	91.7%	\$370	\$51	7.3	\$68	5.4	\$108	3.4
15	88.5%	92.4%	\$495	\$70	7.1	\$93	5.3	\$148	3.3
20	90.2%	93.0%	\$579	\$65	8.9	\$87	6.7	\$138	4.2
25	90.2%	93.6%	\$646	\$98	6.6	\$131	4.9	\$208	3.1
30	90.2%	94.1%	\$729	\$134	5.4	\$179	4.1	\$285	2.6
40	91.0%	94.1%	\$1,042	\$141	7.4	\$188	5.5	\$299	3.5
50	91.7%	94.5%	\$1,214	\$157	7.7	\$210	5.8	\$334	3.6
60	91.7%	94.5%	\$1,515	\$189	8.0	\$252	6.0	\$401	3.8
75	92.2%	94.5%	\$1,743	\$193	9.0	\$257	6.8	\$409	4.3
100	93.0%	94.6%	\$2,666	\$177	15.0	\$236	11.3	\$376	7.1

* DIFFERENTIAL COST DOES NOT INCLUDE LABOR COSTS

APPENDIX C-6
ADD ECONOMIZERS

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: ECONOMIZERS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/17/92
FILE: ECONOG.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	19.64 UPWG
INCREMENTAL ELECTRIC COST	\$0.0255 kWh	15.23 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.68 UPW
ECONOMIC LIFE 15 YRS		

BUILDING NUMBER	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
101	0	37,833	0	129	965	0	0	965	39,924	0.4	41.4

[illegible]

[illegible]

APPENDIX C-7

CONTROL HOT WATER CIRCULATION PUMPS

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO15

LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-7 HW PUMP CONTROL

ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	9868.
B. SIOH	\$	543.
C. DESIGN COST	\$	592.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	11003.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	425.	\$ 3176.	11.11	35290.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	233.	\$ 1088.	14.45	15723.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		658.	\$ 4265.		\$ 51013.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) 10.59

(2) DISCOUNTED SAVING/COST (3A X 3A1) \$ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 16834.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 4265.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 51013.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.64

(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 2.58

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 7 — Hot Water Pumps

EMC PROJECT: #3105.000
DATE: 16-Jul-92

FILE: ECO-7.WK3

PREPARED BY: R. GERRANS
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	0	124,564	233	658	\$4,264	\$0	\$0	\$4,264	\$11,003	4.6	2.6

APPENDIX C-8

INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO15

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-8 WATER FLOW RESTRICTORS

ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	830.
B. SIOH	\$	46.
C. DESIGN COST	\$	50.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	926.

2. ENERGY SAVINGS (+) / COST (-)
 ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	0.	\$ 0.	11.11	0.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	99.	\$ 462.	14.45	6681.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		99.	\$ 462.		\$ 6681.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	550.
(1) DISCOUNT FACTOR (TABLE A)	10.59	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	5825.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	5825.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	2205.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)	9.60	
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 1012.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 12505.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 13.51
 (IF < 1 PROJECT DOES NOT QUALIFY)
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .91

WATER FLOW RESTRICTORS SAMPLE CALCULATION, ECO #8 BUILDING 60

Given:

# of people	= 48 people	-from field survey
Water heater efficiency	= 70%	-assumed
Gas cost	= \$4.67 / MBtu	-from utility rate analysis
Water Cost	= \$2.39 / 1000 gals	-from utility rate analysis

Showers:

# of showers	= 18 showers	-from field survey
Existing water flow	= 3.75 gpm	-from field survey
Improved water flow	= 1.6 gpm	-from field survey
Usage	= (7 min/person day)*(365 days/year)	
	= 2,555 min/person yr	-assumed
Shower water temperature	= 102°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Faucets:

# of faucets	= 36 faucets	-from field survey
Existing water flow	= 2.25 gpm	-from field survey
Improved water flow	= 0.40 gpm	-from field survey
Usage	= (5 min/person day)*(365 days/year)	
	= 1,825 min/person yr	-assumed
Faucet water temperature	= 80°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Annual Existing Flow:

Showers:

$$(48 \text{ people}) * (3.75 \text{ gpm}) * (2,555 \text{ min/yr}) = 459,900 \text{ gal/yr}$$

Faucets:

$$(48 \text{ people}) * (2.25 \text{ gpm}) * (1,825 \text{ min/yr}) = 197,100 \text{ gal/yr}$$

Total:

$$459,900 \text{ gal/yr} + 197,100 \text{ gal/yr} = 657,000 \text{ gal/yr}$$

Annual Improved Flow:

Showers:

$$(48 \text{ people}) * (1.6 \text{ gpm}) * (2,555 \text{ min/yr}) = 196,224 \text{ gal/yr}$$

Faucets:

$$(48 \text{ people}) * (0.40 \text{ gpm}) * (1,825 \text{ min/yr}) = 35,040 \text{ gal/yr}$$

Total:

$$196,224 \text{ gal/yr} + 35,040 \text{ gal/yr} = 231,264 \text{ gal/yr}$$

Annual Non-Energy Savings:

Showers:

$$459,900 \text{ gal/yr} - 196,224 \text{ gal/yr} = 263,676 \text{ gal/yr}$$

Faucets:

$$197,100 \text{ gal/yr} - 35,040 \text{ gal/yr} = 162,060 \text{ gal/yr}$$

Total:

$$657,000 \text{ gal/yr} - 231,264 \text{ gal/yr} = 425,736 \text{ gal/yr}$$

Annual Energy Savings:

Showers:

$$(263,676 \text{ gal/yr}) * (8.33 \text{ lbs/gal}) * (1 \text{ Btu/lb } ^\circ\text{F}) * (102^\circ\text{F} - 66^\circ\text{F}) / 70\% \\ = 113.0 \text{ MBtu/yr}$$

Faucets:

$$(162,060 \text{ gal/yr}) * (8.33 \text{ lbs/gal}) * (1 \text{ Btu/lb } ^\circ\text{F}) * (80^\circ\text{F} - 66^\circ\text{F}) / 70\% \\ = 27.0 \text{ MBtu/yr}$$

Total:

$$113 \text{ MBtu/yr} + 27 \text{ MBtu/yr} = 140 \text{ MBtu/yr}$$

Annual Cost Savings

$$(\$4.67/\text{MBtu}) * (140 \text{ MBtu/yr}) + (\$2.39/1000 \text{ gal}) * (425,736 \text{ gal/yr}) \\ = \$1,671/\text{yr}$$

Estimated Construction Cost:

\$31.74/shower	-from engineer's cost estimate
\$17.36/faucet	-from engineer's cost estimate

$$(\$31.74/\text{ea}) * (18 \text{ showers}) + (\$17.36/\text{ea}) * (36 \text{ faucets}) \\ = \$1,196$$

$$\$1,196 + (\$1,196 * .055 \text{ SIOH}) + (\$1,196 * .06 \text{ DESIGN}) = \$1,334$$

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 8 - Water Flow Restrictors
 CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-8.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / kW	10.59 UPW
Water Savings	\$2.910 / 1000 gals	10.59 UPW
Economic Life: 15 yrs		

C-8.4

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
G935	0	0	99	\$460	\$0	\$550	\$1,010	\$425	29.4	0.4
Include \$500 cost for administration of small contract										
TOTAL	0	0	99	\$460	\$0	\$550	\$1,010	\$925	13.5	0.9

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 8 - WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS:
 WATER \$2.910 / 1000 gals

EMC PROJECT: #3105.000
 DATE: 22-APR-92
 FILE: ECO8.WK3
 PREPARED BY: CHRIS STANLEY
 CHECKED BY:

SHOWER FLOW RESTRICTORS											
BLDG #	# PEOPLE	# SHOWERS	USAGE / YEAR (min/yr)	EXIST FLOW (gpm)	IMPRVD FLOW (gpm)	EXIST FLOW (gal/yr)	IMPRVD FLOW (gal/yr)	WATER TEMP		# FAUCETS	USAGE / YEAR (min/yr)
								SHOWER (°F)	SUPPLY (°F)		
935	30	12	2555	4.50	1.50	344,925	114,975	102	66		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 8 - WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-91 -C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE: 22-APR-92
 FILE: ECO8.WK3
 PREPARED BY: CHRIS STANLEY
 CHECKED BY:

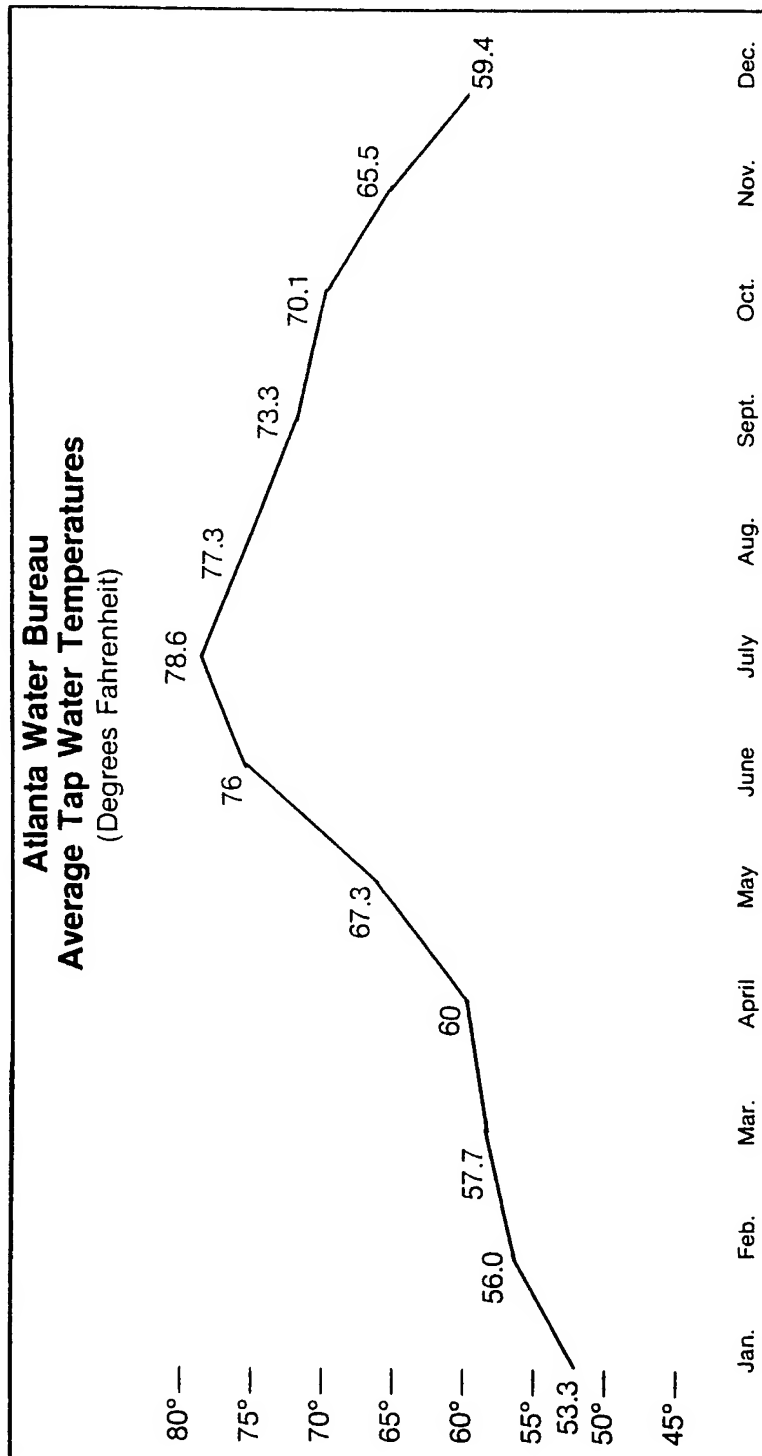
COST SAVINGS:
 WATER \$2.910 / 1000 gals

FAUCET FLOW RESTRICTORS				SAVINGS			COST		
EXIST FLOW (gpm)	IMPRVD FLOW (gpm)	EXIST FLOW (gal/yr)	IMPRVD FLOW (gal/yr)	WATER FAUCET SUPPLY (°F)	WATER HEATER EFF	GAS SAVED (MBtu/yr)	WATER SAVED (gal/yr)	WATER SAVED (\$/yr)	TOTAL COST (\$)
					70%	98.5	229,950	\$550	\$381
								\$31.74	\$17.36

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB 3105.000 / ESOS
SHEET NO _____ OF _____
CALCULATED BY CEL DATE 4/21/92
CHECKED BY _____ DATE _____
SCALE _____



MEAN = 66 °F 9

APPENDIX C-9

HEAT RECLAIM FOR HOT REFRIGERANT GAS

The calculation performed on buildings 500 at Ft. McPherson indicated there were not adequate savings to justify the installation of desuperheaters. Building 500 was a best case analysis. Therefore no additional analysis was performed on other buildings.

The calculations for building 500 are attached for information.

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: HEAT RECLAIM FROM HOT REFRIGERANT GAS

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT:

DATE:

FILE:

PREPARED BY:

CHECKED BY:

#3105.000

07/17/92

HOTGAS.WK3

DENNIS JONES

ENERGY COST		DISCOUNT FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	11.11 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	10.59 UPW
ECONOMIC LIFE 15 YRS		

BUILDING NUMBER	FLOOR AREA (ft ²)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
500		0	0	158	158	738	0	0	738	16,579	0.6	22.5

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

SHEET NO. EMC # 3105.000

OF _____

CALCULATED BY _____

DATE _____

CHECKED BY _____

DATE _____

SCALE _____

BLDG. 500

Assume

- 1) 7.5 ton chiller on 10' * 10' walk in cooler
- 2) Assume 50% operation * 2 chillers = 7.5 tons.
- 3) Desuperheaters will produce 2600 Btu/ton in heating water from 75 °F to 140 °F.

For one day, hot water produced is:

$$\frac{2 * 0.50 * 7.5 \text{ tons} * 2600 \text{ Btu lbm } ^\circ\text{F gal} * 24 \text{ hrs}}{(140 - 75) ^\circ\text{F hr ton Btu} * 8.3 \text{ lbm}} = 867 \text{ gallons available heat}$$

Restaurants use 2.4 gallons per meal (ASHRAE HVAC 1991 44.10).

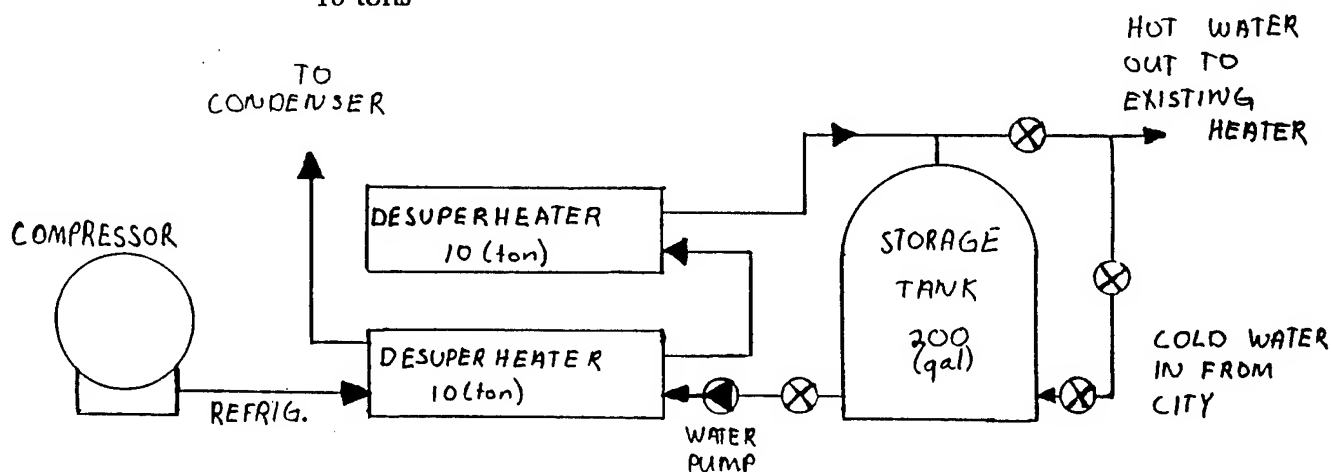
$$250 \text{ meals / day} * 2.4 \text{ gal / meal} = 600 \text{ gallons HW Demand}$$

Heat reclaimed overnight must be stored, use 50%, 300 gallons storage capacity.

Maximum heat production:

$$\text{For 10 ton unit, } 75 ^\circ\text{F} - 140 ^\circ\text{F heat gain: } \frac{10 \text{ ton} * 2,600 \text{ Btu/h}}{500 * 52 ^\circ\text{F}} = 0.8 \text{ gpm}$$

$$\frac{7.5 \text{ tons} * 2 \text{ chillers} * .8 \text{ gpm}}{10 \text{ tons}} = 1.2 \text{ gpm pump size}$$



$$\text{Gas saved} = \frac{600 \text{ gal} * (140 - 75) ^\circ\text{F} * 8.3 \text{ lbs} * \text{Btu} * 365 \text{ days} * \text{MBtu}}{^\circ\text{F} * \text{gal} * .75 * \text{yr} * 1,000,000 \text{ Btu}} = 157.75 \text{ MBtu / yr}$$

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JOB Ft. McPherson / Ft. Gillem ESOS StudySHEET NO. EMC # 3105.000

OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

CHILLER SIZE (tons)	<u>75 °F - 140 °F DELTA T</u>		<u>115 °F - 140 °F DELTA T</u>	
	FLUID FLOW (gpm)	HEAT PROD. (Btuh)	FLUID FLOW (gpm)	HEAT PROD. (Btuh)
10	0.8	26,000	1.9	23,750
20	1.6	52,000	3.8	47,500
30	2.4	78,000	5.7	71,250
40	3.2	104,000	7.6	95,000
50	4.0	130,000	9.5	118,750
60	4.8	156,000	11.4	142,500
70	5.6	182,000	13.3	166,250
80	6.4	208,000	15.2	190,000
90	7.2	134,000	17.1	213,750
100	8.0	160,000	19.0	237,500

- from manufacturer's literature

JOB Ft. McPherson / Ft. Gillem ESOS Study
EMC # 3105.000

SHEET NO _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

E M C ENGINEERS, INC.


Denver • Colorado Springs • Atlanta • Germany

ECO-9 HEAT RECLAIM FROM HOT REFRIGERANT GAS

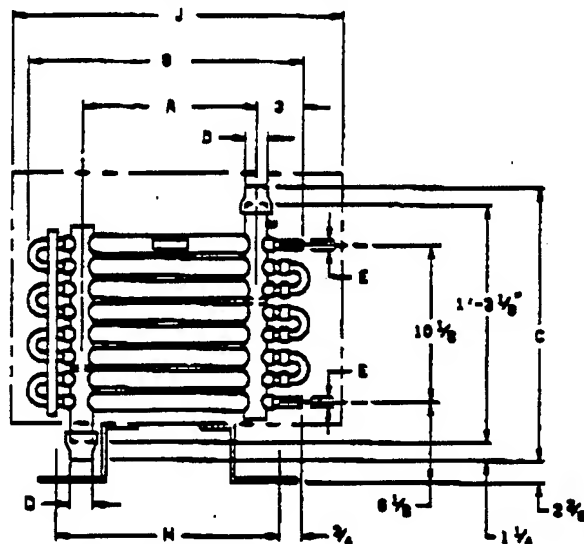
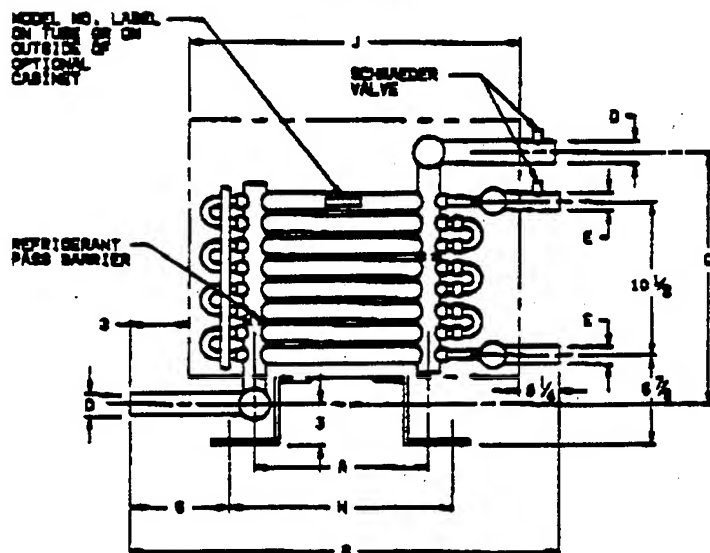
A heat exchanger called a desuperheater will produce about MBtu of heat per ton of cooling. The desuperheater will provide hot water up to about 100 °F. Successful ECM requires significant DHW load to use the heat. Trane Co. provided the following costs for desuperheaters and refrigerant piping with installation costs included. Water side piping is not included.

<u>TONS</u>	<u>COST</u>
10	\$2000
20	\$2800
30	\$3700
40	\$5000
50	\$6000
60	\$7500
80	\$9800
100	\$12,200
120	\$15,500
160	\$20,000
200	\$23,000

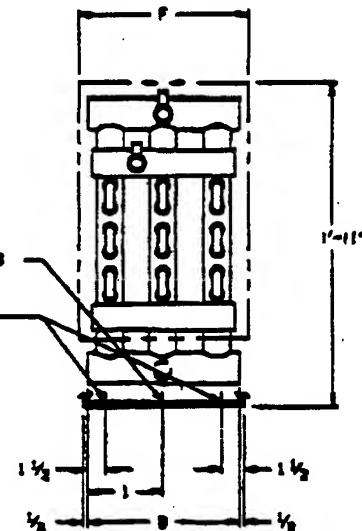
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PRINT DATE: 8-1-83	FILE NO: PL-SV-CG-RDHA-SU-001.01	REPLACES: RDHA-SU-001.00	RDHA-SU-001.01
		AIR COOLED RECIPROCATING UNITS DESUPERHEATER / WATER HEATER RDHA 10 THRU 100 TONS	
SUBMITTAL		(RDHA-S-1)	

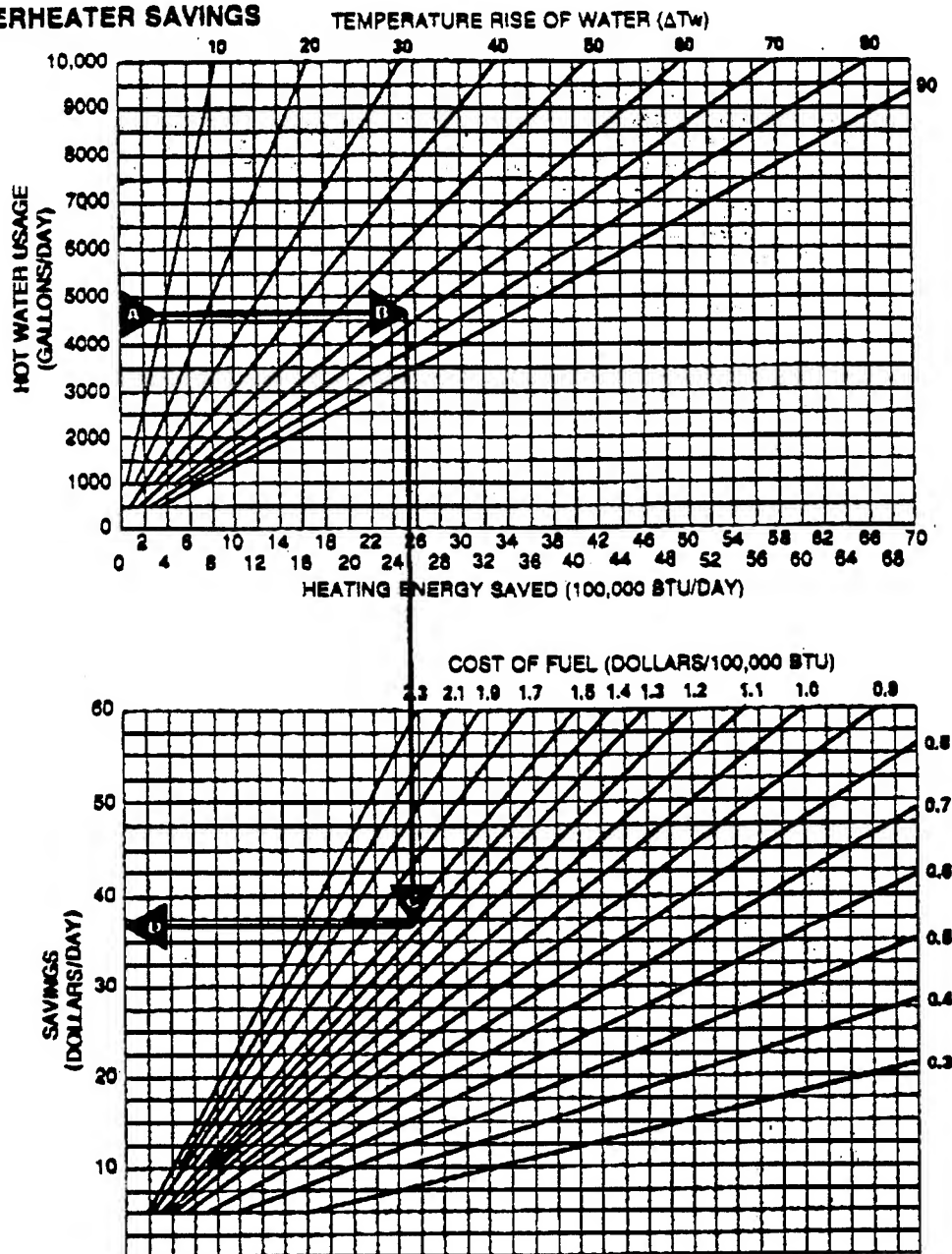
UNIT SIZE	NO OF SECTIONS	A	B	C	REFRIG ID D	WATER CO E	F	G	H	J	EST UNIT WEIGHT (LBS)	EST UNIT WEIGHT WITH CABINET (LBS)
10	1	3'-8"	2	1'-5 1/2"	1 1/2	3/8	2 3/4	4'-2"	4'-0 1/2"	4'-8 1/2"	84	85
10-08		4'-8"						5'-0"	4'-10 1/2"	5'-4 1/2"	77	114
20	2	3'-8"	4	1'-5 3/4"	1 1/2	7/8	4 3/4	6'-2 1/2"	4'-0 1/2"	4'-8 1/2"	115	148
20-08		4'-8"						6'-0 1/2"	4'-10 1/2"	5'-4 1/2"	137	177
30	3	3'-8"	6	1'-5 3/4"	1 3/8	1 1/8	6 3/4	8'-2 1/2"	4'-0 1/2"	4'-8 1/2"	181	187
30-08		4'-8"						8'-0 1/2"	4'-10 1/2"	5'-4 1/2"	185	238
40	4	3'-8"	8	1'-5 3/4"	1 3/8	1 3/8	8 3/4	8'-2 1/2"	4'-0 1/2"	4'-8 1/2"	212	252
40-08		4'-8"						8'-0 1/2"	4'-10 1/2"	5'-4 1/2"	253	289
50	5	3'-8"	10	1'-5 3/4"	1 3/8	1 3/8	10 3/4	8'-2 1/2"	4'-0 1/2"	4'-8 1/2"	260	303
50-08		4'-8"						8'-0 1/2"	4'-10 1/2"	5'-4 1/2"	310	359
60	6	3'-8"	1'-0"	1'-5 3/4"	2 1/8	1 3/8	1'-0 3/4"	8'-2 1/2"	4'-0 1/2"	4'-8 1/2"	311	357
60-08		4'-8"						8'-0 1/2"	4'-10 1/2"	5'-4 1/2"	389	422
80	8	3'-8"	1'-4"	1'-5 3/4"	2 1/8	2 1/8	1'-4 3/4"	8'-2 1/2"	4'-0 1/2"	4'-8 1/2"	411	482
80-08		4'-8"						8'-0 1/2"	4'-10 1/2"	5'-4 1/2"	487	547
100	10	3'-8"	1'-8"	1'-5 3/4"	2 3/8	2 1/8	1'-8 3/4"	8'-2 1/2"	4'-0 1/2"	4'-8 1/2"	508	585
100-08		4'-8"						8'-0 1/2"	4'-10 1/2"	5'-4 1/2"	602	669

10 TON UNIT
FRONT VIEW20-100 TON UNITS
FRONT VIEW

10 AND 20 TON UNITS
HAVE ONLY CENTER
3/16
20-100 TON UNITS
HAVE 2 3/16
MOUNTING HOLES

END VIEW
(30 TON UNIT SHOWN)

ANNUAL DESUPERHEATER SAVINGS



EXAMPLE:

1. A 40-ton unit operating at full capacity can generate 192 gallons of hot water per hour when heated from 75 F to 140 F. This is equal to 4,608 gallons per day. Locate 4,608 gallons per day on the nomograph (point A).
2. The ΔT_w is $140\text{ F} - 75\text{ F} = 65\text{ F}$. Follow the horizontal line at 4,608 gallons per day across to 65 F ΔT_w (point B).
3. Drop vertically to the lower section of the nomograph to the cost per 100,000 Btu. In this case let's use an electric water heater at \$0.05 per kwh to yield a cost of \$1.47 per 100,000 Btu (point C).
4. Run horizontally to the left to \$37/day savings (point D).
5. If this air conditioning unit operated at full capacity for 120 days per year, the desuperheater would provide the following yearly savings:

$$\frac{\$37}{\text{day}} \times 120 \text{ operating days/year} = \frac{\$4,440}{\text{year}}$$

Depending on the installation, this savings could result in a payback period as low as one year!

UP TO 12% HIGHER OPERATING EFFICIENCIES

But the energy savings derived from Trane desuperheaters continue beyond 'free' hot water. Desuperheaters also deliver increased unit efficiency.

Desuperheaters remove heat from the discharge gas before it reaches the condenser coil. This allows the condenser to work more efficiently and, in turn, allows your air conditioner to provide more cooling with the same amount of energy or less. Increasing your total unit operating efficiency by up to 12 percent!

APPENDIX C-10

PREVENT AIR STRATIFICATION

**PREVENT AIR STRATIFICATION, ECO #10
BUILDING 512**

Given:

Gas Savings Factor	= 0.00342 MBtu / ft ²	- from Bldg 207 simulation
Electric Savings Factor	= -0.42832 Kwh / ft ²	- from Bldg 207 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 207 simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Peak Demand Savings:

$$(120,327 \text{ ft}^2) * (0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

- Gas:	$(120,327 \text{ ft}^2) * (0.00342 \text{ MBtu} / \text{ft}^2)$	= 412 MBtu
- Electric:	$(120,327 \text{ ft}^2) * (-0.42832 \text{ kWh} / \text{ft}^2)$	= -51,538 kWh

Annual Cost Savings:

$$(412 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (-51,538 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$616 / \text{yr}$$

Estimated Construction Cost:

$$\begin{aligned} & \$194.37 \text{ per } 1,000 \text{ sq. ft.} * 120,327 \text{ sq. ft.} = \$23,388 \\ & \$23,388 + (\$23,388 * 0.055 \text{ SIOH}) + (\$23,388 * 0.06 \text{ DESIGN}) = \$26,077 \end{aligned}$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: PREVENT AIR STRATIFICATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT:
DATE: 07/20/92
FILE: DESTRAT.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

#3105.000
07/20/92
DESTRAT.WK3
DENNIS JONES

ENERGY COST		DISCOUNT FACTOR	SAVINGS FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG	0.00342 MBtu/ft2
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	11.11 UPWE	-0.42832 kWh/ft2
ELECTRIC DEMAND CHARGE	\$102.66 kW	10.59 UPW	0.00000 kW/ft2
ECONOMIC LIFE		15 YRS	

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
207	149,300	0	(63,948)	511	293	749	0	0	749	32,357	0.5	43.2
102	20,000	0	(8,566)	68	39	100	0	0	100	4,334	0.5	43.2
214	166,920	0	(71,495)	571	327	838	0	0	838	36,175	0.5	43.2
400	76,623	0	(32,819)	262	150	385	0	0	385	16,606	0.5	43.2
401	10,000	0	(4,283)	34	20	50	0	0	50	2,167	0.5	43.2
512	120,327	0	(51,538)	412	236	604	0	0	604	26,078	0.5	43.2
TOTAL		0	(232,650)	1,859	1,065	2,726	0	0	2,726	117,717	0.5	43.2

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • West Germany

JOB Ft. McPherson / Ft. Gillem ESOS StudySHEET NO EMC # 3105.000

OF _____

CALCULATED BY _____

DATE _____

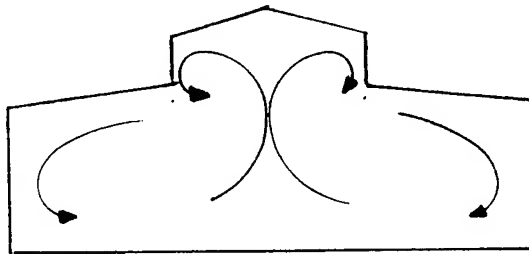
CHECKED BY _____

DATE _____

SCALE _____

DESTRATIFICATION FANSMFG DATA: 41,000 CFM fan for 5000 ft², 20 feet high ceiling

$$\frac{41,000 \text{ ft}^3 \text{ 60 MIN}}{(5000 \text{ ft}^2 * 20 \text{ ft}) \text{ hr min}} = 24.6 \text{ ACH}$$



Floor area

149,600 ft²

Volume (22 ft ceiling)

3,291,200 ft³

Measured Stratification

3°F @ 40°F outside air temp.

Increasing air changes to 25 ACH will likely result in 1°F of stratification.

$$\frac{25 \text{ ACH} * 3,291,200 \text{ ft}^3}{60 \text{ min per hr}} = 1,371,333 \text{ cfm}$$

OPTION 1:

Green Heck Ventilation unit is 40,000 cfm.

$$\frac{1,371,333 \text{ cfm}}{40,000} = 34 \text{ units}$$

Each unit has a 10 hp Green Heck motor. $10 \text{ hp} * 0.746 \text{ kW} * .85/.865 = 7.3 \text{ kW}$
 34 units * 7.3 kW = 248 total kW

OPTION 2:

A 60" industrial ceiling fan has 41,000 cfm and costs considerably less.

$$\frac{1,371,333 \text{ cfm}}{41,000} = 33 \text{ units}$$

Each unit has a 145 watt motor.

$$\frac{145 \text{ watts} * 33 \text{ units} * 1 \text{ kW}}{1000 \text{ watts}} = 4.78 \text{ total kW}$$

JOB Ft. McPherson / Ft. Gillem ESOS Study
EMC # 3105.000

SHEET NO _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

DESTRATIFICATION FANS, COST ESTIMATE

COSTS

1 fan per 5000 ft² @ \$170 and 5 man hours per fan.

A total of 75 fans (15 per section) are needed.

Electrical use, 145 watts per 5000 ft² = 0.03 W/ft².

\$.08/ft² for wire and conduit.

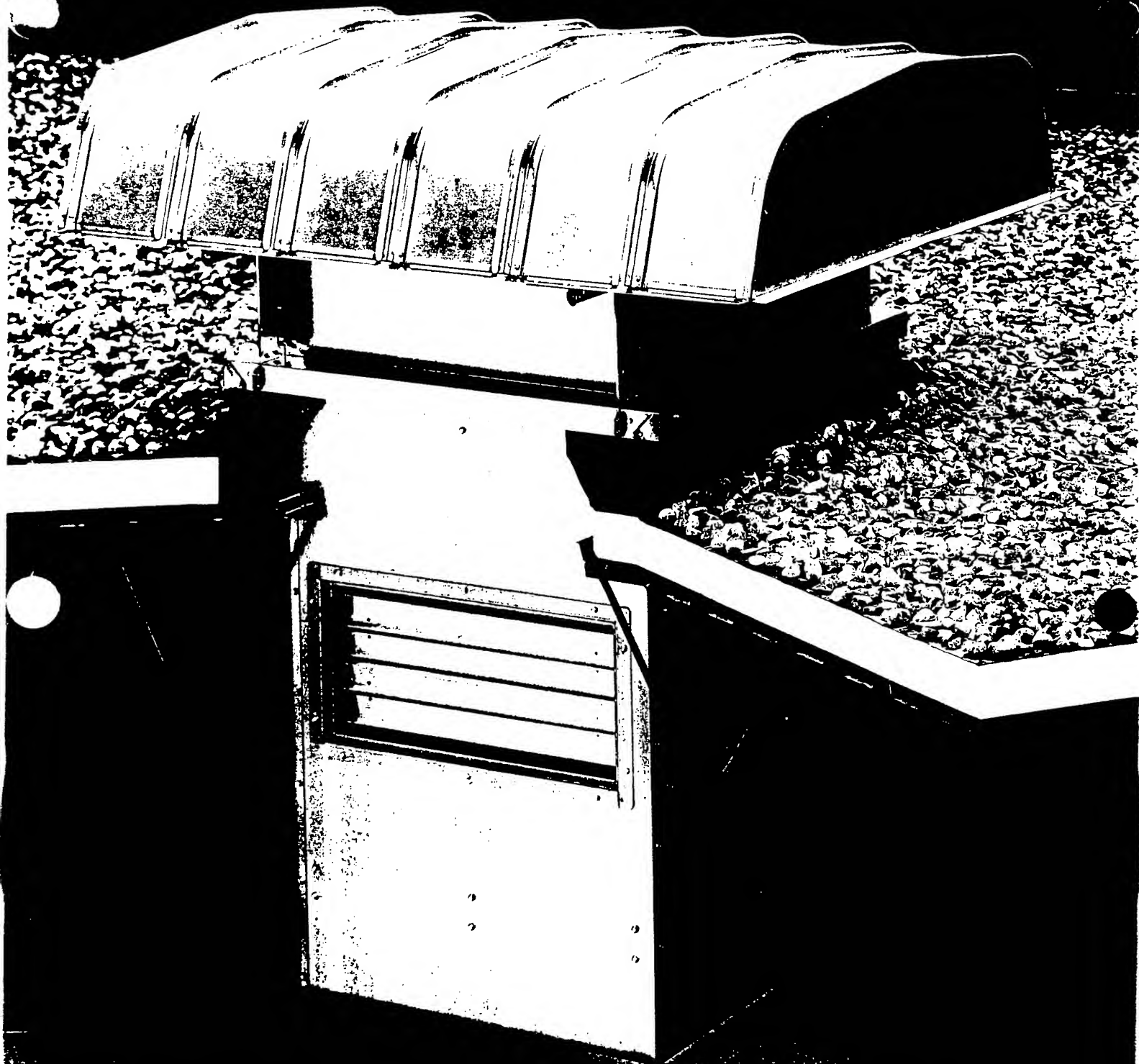
FAN \$34 + 1 man hour per 1000 ft²

POWER \$80 per 1000 ft²

LABOR \$60 per 1000 ft²

MATERIALS \$20 per 1000 ft²

FOUR WAY FAN



One Fan - Four Functions

- Exhaust
- Supply
- Recirculate
- Mix

 **GREENHECK**

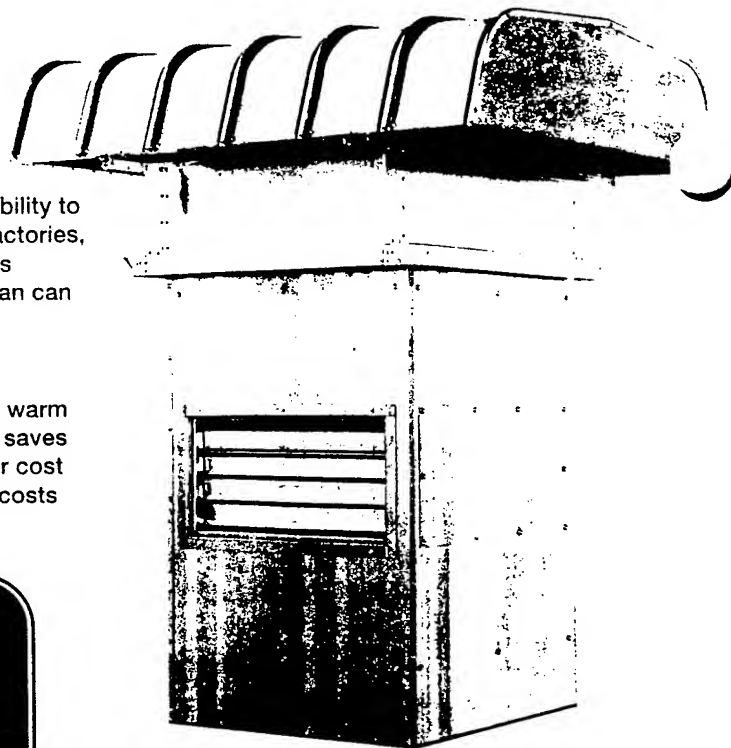
Four Way Fan

Model ESRMD Direct Drive - Roof Fan (Exhaust/Supply/Recirculation/Mix)

Ventilation requirements are often subject to daily or seasonal changes in temperature. The Greenheck Four Way fan offers the flexibility to meet changing needs and to maintain comfortable temperatures in factories, warehouses and other facilities with high ceilings. When temperatures change with production processes or seasonal shifts, the Four Way fan can exhaust, supply, recirculate or mix air as required.

Cost Savings

By exhausting excess heat, supplying cool air, recirculating stratified warm air, and mixing supply air with recirculated air, the Four Way fan also saves heating and cooling costs. When one fan offers four functions, further cost reductions result. Fewer fans required on the job means lower initial costs and lower installation costs, with fewer roof penetrations.



Sizes

Model ESRMD fans are available in six sizes, 24"-54."

Performance

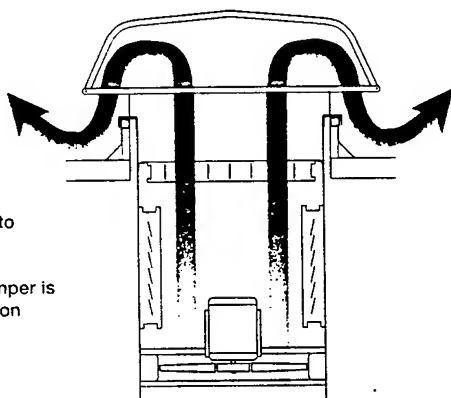
Performance capacities extend from 4,000 CFM to 40,000 CFM and static pressures to 3/8". Performance in the exhaust, supply, and recirculate modes is equal.

One Fan - Four Functions

1. Exhaust

Evacuates excess heat to reduce cooling costs.

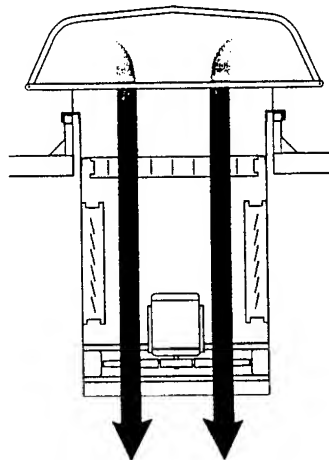
The exhaust/supply damper is open and the recirculation dampers are closed.



2. Supply

Fresh air can be supplied when outside temperatures are cooler (as at night) to reduce cooling costs.

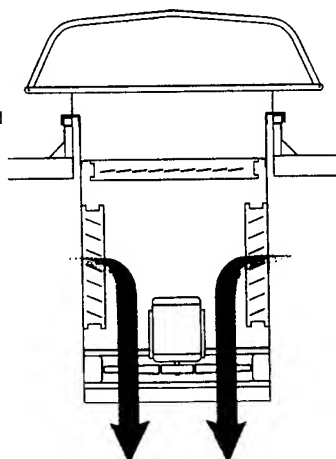
The exhaust/supply damper is open and the recirculation dampers are closed.



3. Recirculation

De-stratifies warm air accumulated at ceiling level and directs it downward to reduce heating costs.

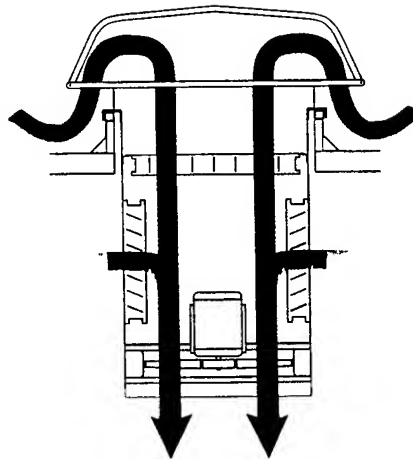
The exhaust/supply damper is closed and the recirculation dampers are open.



4. Mix

Comfortable temperatures can be maintained by tempering supply air with warmer air trapped at ceiling level.

The exhaust/supply damper and the recirculation dampers are linked to work in combination.



CONSTRUCTION FEATURES

Fan hoods and bases are constructed of galvanized steel. Aluminum construction is optional. Hood panels are arched and precision roll formed for strength and weather tightness. Hoods are bolted to heavy gauge support angles. Hoods for all fan sizes except 54" ship fully assembled.

Birdscreens are constructed of 1/2" galvanized steel mesh. Filters are optional.

The plenum is galvanized steel supported at the roof curb by mounting channels. Two removable access panels are provided for ease of maintenance. Four lifting lugs are provided for ease of installation. (See important plenum height information on pg. 4.)

Model ESRMD propellers are designed to produce a high level of efficiency over a broad selection range. Tapered airfoil blades are cast of aluminum alloy. The propeller is designed to deliver equal air flow in the exhaust, supply, and recirculate modes. Each propeller is balanced prior to assembly.

A 12" high base is standard. Bases include prepunched mounting holes for ease of installation.

A low leakage control damper (exhaust/supply) and two standard control dampers (recirculation) are linked for recirculation and mixing. Construction is galvanized steel.

Standard damper actuators are modulating spring return.

Heavy duty ball bearing motors are carefully matched to the fan load.

Motor support frames are constructed of heavy gauge steel angles.

Fan panels are constructed of heavy gauge steel with a double venturi for efficient air flow.

Installation Sequence

1. The roof curb is mounted and secured over the roof opening.
2. The plenum (factory assembled) is lowered through the curb and roof opening until its mounting channels rest on the roof curb. Lifting lugs are provided. (Fig. 1)
3. The fan hood is lowered onto the curb/plenum assembly. (Fig. 1)
4. The hood and plenum are secured to the roof curb. (Fig. 2)

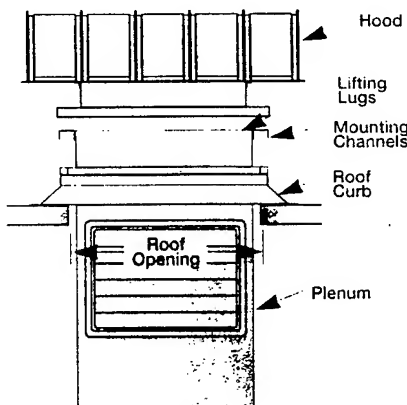


Fig. 1

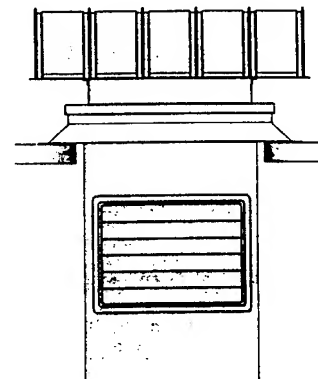


Fig. 2

APPENDIX C-11
REPLACE STREET LIGHTS

LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) STUDY: GECO25
 INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3
 PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
 FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-11 RPLACE STREET LIGHTS
 ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	2405.
B. SIOH	\$	133.
C. DESIGN COST	\$	145.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	2683.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	17.	\$ 126.	15.61	1962.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		17.	\$ 126.		\$ 1962.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	174.
(1) DISCOUNT FACTOR (TABLE A)		14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	2528.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	2528.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	647.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .97		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 300.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 4490.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.67
 (IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 8.95

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-11: REPLACE EXTERIOR LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/01/92
FILE: EXT_LITES.WK3
PREPARED BY: JIM WATTERS
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.53 UPW
ECONOMIC LIFE		
ESTIMATED 3285 HOURS OF EXTERIOR LIGHTING PER YEAR		
25 YRS		

Existing Bulb Wattage (WATTS)	Existing Bulb Type	Number of Bulbs	Replacement Bulb Wattage (WATTS)	Replacement Bulb Type	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENERGY SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
1500	QUARTS	0	400	HPS*	0	0	0	0	\$0	\$0	\$0	\$0	\$0		
500	QUARTS	5	200	HPS*	0	4927.5	0	17	\$126	\$0	\$174	\$300	\$2,682	1.7	8.9
400	MERCURY	2	360	HPS	0	262.8	0	1	\$7	\$0	\$0	\$7	\$176	0.6	26.2
175	MERCURY	122	150	HPS	0	10019.3	0	34	\$256	\$0	\$0	\$256	\$9,114	0.4	35.5

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.

EFFECTIVE PRICING

DATE PREPARED

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

DACA 21-91-C-0097

DATE APR 92

LOCATION Ft. McPherson & Ft. Gillem

X CODE A CODE B CODE C

DRAWING NO.

SHT OF

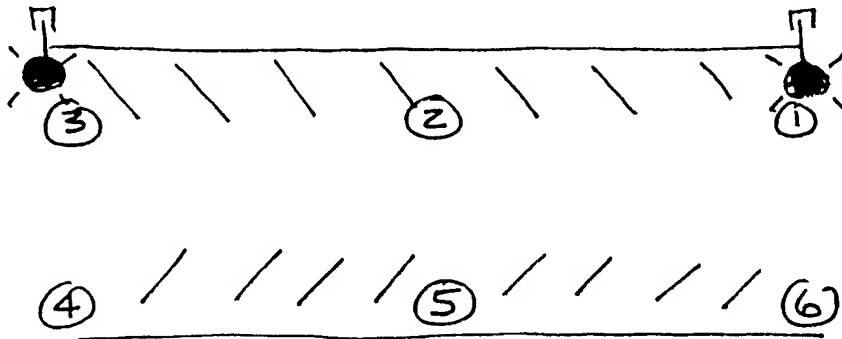
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SHIPPING

EXTERIOR LIGHTING TASK DESCRIPTION	Quantity		LABOR		EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
400 W HPS LAMP w/ FIXTURE	1	EA	4	4	\$21.17	\$84.68	\$275.00	\$275.00	\$359.68		
OVERHEAD, BOND	15%					\$12.70		\$41.25	\$53.95		
PROFIT	10%					\$8.47		\$27.50	\$35.97		
COST SUB-TOTAL						\$105.85		\$343.75	\$49.60		
CONTINGENCY	15%					\$15.88		\$51.56	\$67.44		
TOTAL						\$121.73		\$395.31	\$517.04		
200 W HPS LAMP w/ FIXTURE	1	EA	4	4	\$21.17	\$84.68	\$250.00	\$250.00	\$334.68		
OVERHEAD, BOND	15%					\$12.70		\$37.50	\$50.20		
PROFIT	10%					\$8.47		\$25.00	\$33.47		
COST SUB-TOTAL						\$105.85		\$312.50	\$418.35		
CONTINGENCY	15%					\$15.88		\$46.88	\$62.75		
TOTAL						\$121.73		\$359.38	\$481.10		
360 W HPS LAMP	1	EA	1	1	\$21.17	\$21.17	35	\$35.00	\$56.17		
OVERHEAD, BOND	15%					\$3.18		\$5.25	\$8.43		
PROFIT	10%					\$2.12		\$3.50	\$5.62		
COST SUB-TOTAL						\$26.46		\$43.75	\$70.21		
CONTINGENCY	15%					\$3.97		\$6.56	\$10.53		
TOTAL						\$30.43		\$50.31	\$80.74		
150 W HPS LAMP	1	EA	1	1	\$21.17	\$21.17	25	\$25.00	\$46.17		
OVERHEAD, BOND	15%					\$3.18		\$3.75	\$6.93		
PROFIT	10%					\$2.12		\$2.50	\$4.62		
COST SUB-TOTAL						\$26.46		\$31.25	\$57.71		
CONTINGENCY	15%					\$3.97		\$4.69	\$8.66		
TOTAL						\$30.43		\$35.94	\$66.37		

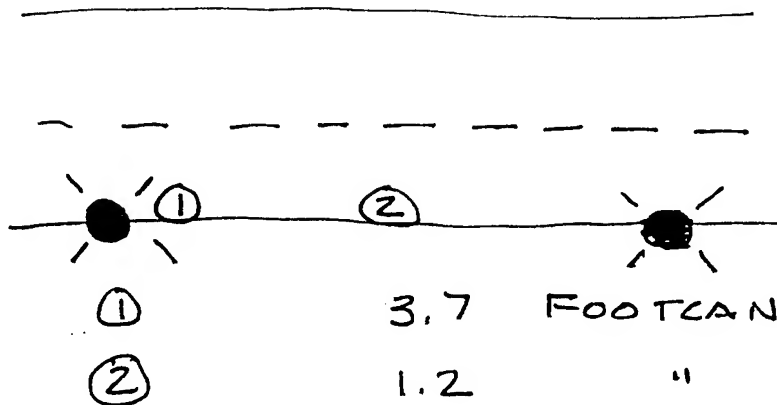
E M C ENGINEERS, INC.
 Denver • Colorado Springs • Atlanta • Germany

STREET LIGHT READINGS
 PARKING LOT BEHIND B.200



①	—	2.07	FOOTCANDLES
②	—	0.35	"
③	—	2.10	"
④	—	0.37	"
⑤	—	0.10	"
⑥	—	0.35	"

STREET BEHIND PX



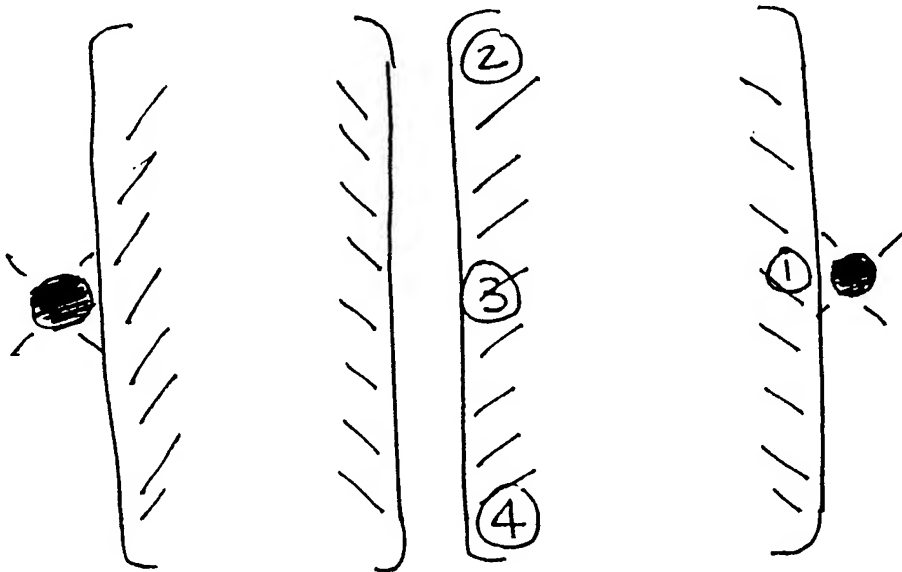
①	3.7	FOOTCANDLES
②	1.2	"

JOB FT. McPHERSON / GILLEM
 SHEET NO. EMC# 3105,000 OF
 CALCULATED BY CEL DATE 7/21/92
 CHECKED BY DATE
 SCALE

E M C ENGINEERS, INC.

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STREET LIGHT READINGS PARKING LOT IN FRONT OF B 200



①	—	2.07	FOOTCANDIES
②	—	0.17	"
③	—	0.33	"
④	—	0.03	"

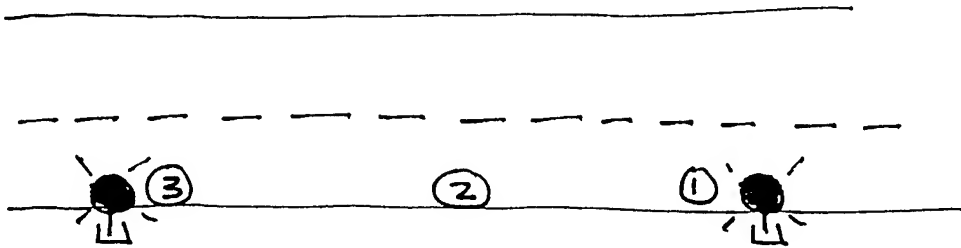
CROSS WALK IN FRONT OF BLDG 200

0.80 FOOTCANDIES

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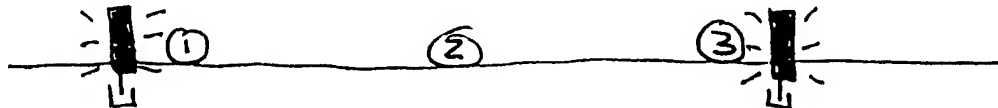
STREET LIGHT READINGS

STREET IN FRONT OF B. 200



①	—	3.4	FOOTCANDLES
②	—	0.13	"
③	—	3.4	"

STREET IN FRONT OF B. 168



①	—	0.7	FOOTCANDLES
②	—	0.09	"
③	—	0.18	"

E M C ENGINEERS, INC.

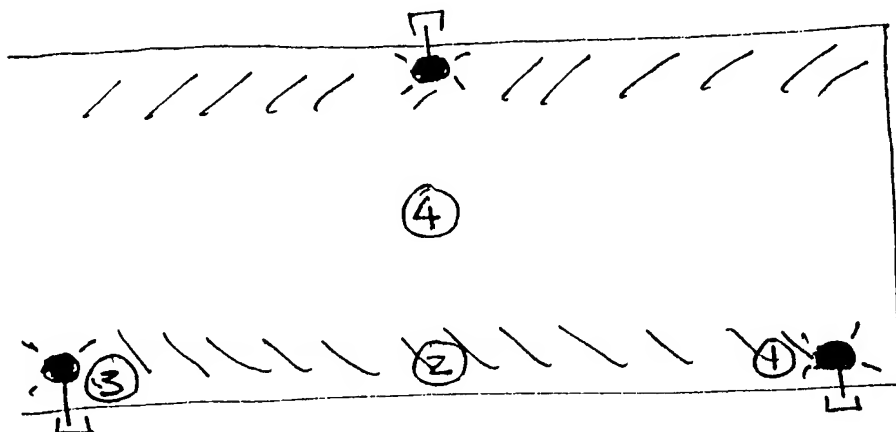
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JOB FT. MCPHERSON / GILLEM
SHEET NO. EMC # 3105,000 OF
CALCULATED BY CEL DATE 7/21/92
CHECKED BY DATE
SCALE

STREET LIGHT READINGS

BLDG

PARKING LOT



①	—	2.47	FOOTCANDLES
②	—	0.23	"
③	—	2.33	"
④	—	0.64	"

Fig. 14-18. Recommended Maintained Illuminances for Open and Covered Parking Facilities

Level of Activity	Open Parking Facilities							
	For Vehicular Traffic			For Pedestrian Safety		For Pedestrian Security		
	Lux*	Footcand- les*	Uniformly Ratio	Lux**	Footcand- les**	Lux*	Footcand- les*	Uniformly Ratio
Low activity	5	0.5	4:1	2	0.2	9	0.8	5:1
Medium activity	11	1	3:1	6	0.6	22	2	5:1
High activity	22	2	3:1	10	0.9	43	4	5:1

Areas	Covered Parking Facilities			
	Day		Night	
	Lux***	Footcandles***	Lux*	Footcandles*
General parking and pedestrian areas	54	5	54	5
Ramps and corners	110	10	54	5
Entrance areas	540	50	54	5
Stairways and lobbies (refer to Fig. 2-2)				

* Average on pavement

** Minimum on pavement

*** Average on pavement—sum of electric lighting and daylight

the "High" activity lighting levels may be required, but while the game is being played or during hours of reduced activity the "Medium" or "Low" activity lighting levels may be adequate.

ROADWAY ILLUMINATION DATA AND CALCULATIONS

The following is an example of a simple and straightforward calculation procedure to determine average illuminance and illuminance at a specific point on a roadway. For a detailed treatment of the subject, including calculations for high-mast and pedestrian walkway lighting, the reader is referred to Reference 1.

Determination of Average Illuminance

The average illuminance over a large pavement area in terms of lux (footcandles) may be calculated by means of a "utilization curve" of the type shown in Fig. 14-19.

Utilization Curves. Utilization curves, available for various types of luminaires, afford a practical method for the determination of average illuminance over the roadway surface where lamp size, mounting heights, width of roadway, overhang and spacing between luminaires are known or assumed. Conversely, the desired spac-

ing or any other unknown factor may readily be determined if the other factors are given.

The Coefficient of Utilization, as shown in Fig. 14-19, is the percentage of rated lamp lumens which will fall on either of two strip-like areas of infinite length, one extending in front of the luminaire (street side), and the other behind the luminaire (house side), when the luminaire is level and oriented over the roadway in a manner equivalent to that in which it was tested. Since roadway width is expressed in terms of a ratio of luminaire mounting height to roadway width, the term has no dimensions.

Light Loss Factors. There are a number of causes of light loss. They are listed on page 4-21. For each cause, a factor can be determined. All individual factors can be multiplied together to obtain one total light loss factor. Some factors, usually due to less than ideal operating conditions, exist initially and continue through the life of the installation. They may, however, have too little effect to justify correction or be too costly to correct. The significant light loss factors in roadway calculations are:

Lamp Lumen Depreciation. Information about lamp lumen depreciation is available from manufacturers' tables and graphs for lumen depreciation and mortality of the chosen lamp. Rated average life should be determined for the specific hours per start; it should be known when burnouts will begin in the lamp life cycle. From these facts, a practical group relamping cycle will be established and then, based on the hours elapsed to lamp removal, the specific lamp lumen depreciation (LLD) factor can be determined.

APPENDIX C-12

REVISE OR REPAIR HVAC CONTROLS

STUDY: GECO15
LCCID 1.062

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-12 HVAC CONTROLS
ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	51612.
B. SIOH	\$	2839.
C. DESIGN COST	\$	3097.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	57548.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	973.	\$ 7272.	11.11	80794.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	302.	\$ 1410.	14.45	20379.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		1275.	\$ 8683.		\$ 101174.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	5979.
(1) DISCOUNT FACTOR (TABLE A)	10.59	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	63318.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	63318.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	33387.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E	2.34	
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS\ ECONOMIC\ LIFE))$ \$ 14662.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 164491.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.86
(IF < 1 PROJECT DOES NOT QUALIFY)
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 3.93

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 12 -- HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92

FILE: ECO-12.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / kW	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	57	285,187	302	1,274	\$8,683	\$5,852	\$127	\$14,661	\$57,547	2.9	3.9

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 12 - HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE:
 FILE: ECO-12.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

BLDG #	EQUIPMEN	#	UNIT COST (\$/ea)	SUB-TOTAL (\$)	TOTAL COST (\$)
G101				\$51,612	\$57,547
	DDC Panel	1	\$8,050.00		
	AHU	3	\$3,154.00		
	Chiller	6	\$3,577.00		
	Conv	1	\$4,384.00		
	Boiler	2	\$4,127.00		

EQUIPMENT COSTS:

DDC Panel	\$8,050
FCU	\$3,154
AHU	\$3,154
MZ AHU	\$9,192
Chiller	\$3,577
Conv	\$4,384
Boiler	\$4,127

$$(SUB-TOTAL) + (SUB-TOTAL * .055 SIOH) + (SUB-TOTAL * .06 DESIGN) = TOTAL COST$$

COST ESTIMATE ANALYSIS

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

EFFECTIVE PRICING DATE April 92

DRAWING NO.

DATE PREPARED 16-Apr-92

X CODE A CODE B CODE C

OTHER

SHT OF

CHECKED BY CEL

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft. Gillem

AHU		TASK DESCRIPTION	Quantity		LABOR			EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
			No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost	Unit Price		Cost	Unit Wt
		STS	1	EA	1.5	1.5	21.17					\$118.00	\$118.00	\$149.76
		DTS	1	EA		2	21.17					\$160.00	\$160.00	\$202.34
		VALVE	1	EA		2.0	21.17					\$370.00	\$370.00	\$412.34
		ST/SP	1	EA		2.0	21.17					\$66.00	\$66.00	\$108.34
		FAN DPS	1	EA		2.0	21.17					\$59.00	\$59.00	\$101.34
		WIRE AND CONDUIT	5									\$94.00	\$470.00	\$470.00
		PROGRAMMING	5					\$750.00						\$750.00

16-Apr-92

511

CHECKED BY

TOTAL THIS SHEET

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

☒ CODE A ☐ CODE B ☐ CODE C
☐ OTHER

DATE PREPARED

16-Apr-92

SHT OF

EFFECTIVE PRICING

DATE APR. 92

DRAWING NO.

CHECKED BY CEL

SHIPPING

ESTIMATOR RMG

TOTAL

TASK DESCRIPTION	Quantity		LABOR		EQUIPMENT		MATERIAL		TOTAL		SHIPPING	
	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost			Unit Wt	Total Wt
STS	4	EA	1.5	6.0	21.17	85	118	472.00	557			
DTS	3	EA	2.0	6.0	21.17	64	160	480.00	544			
VALVE	2	EA	2.0	4.0	21.17	42	370	740.00	782			
DAMPER	4	EA	1.3	5.2	21.17	85	150	600.00	685			
ST/SP	1	EA	2.0	2.0	21.17	21	66	66.00	87			
FAN DPS	1	EA	2	2.0	21.17	21	59	59.00	80			
WIRE AND CONDUIT	15						\$94.00	\$1,410.00	\$1,410.00			
PROGRAMMING	15					\$2,250.00			\$2,250.00			
SUBTOTAL						\$2,568			\$3,827	\$6,395		
CONTINGENCY	15%					\$385			\$574	\$959		
COST SUB - TOTAL						\$2,953			\$4,401	\$7,354		
OVER-HEAD, BOND	15%					\$443			\$660	\$1,103		
PROFIT	10%					\$295			\$440	\$735		
SUBTOTAL						\$3,691			\$5,501	\$9,192		
TOTAL THIS SHEET						\$3,691			\$5,501	\$9,192		

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

☒ CODE A ☐ CODE B ☐ CODE C
☐ OTHER

EFFECTIVE PRICING
DATE APR. 92

DRAWING NO.

DATE PREPARED
16-Apr-92

SHT OF

CHECKED BY CEL

TASK DESCRIPTION	Quantity		LABOR		EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
CHILLER											
WTS	2	EA	5.0	10.0	21.17	42	261	522.00	564		
ST/SP	1	EA	2.0	2.0	21.17	21	66	66.00	87		
PUMP DPS	1	EA	2.5	2.5	21.17	21	129	129.00	150		
STATUS RELAY	2	EA	1.0	2.0	21.17	42	90	180.00	222		
WIRE AND CONDUIT	6						\$94.00	\$564.00	\$564.00		
PROGRAMMING	6					\$900.00			\$900.00		
SUBTOTAL											
CONTINGENCY	15%					\$1,027			\$1,461		\$2,488
COST SUB-TOTAL						\$154			\$219		\$373
OVERHEAD, BOND	15%					\$1,181			\$1,680		\$2,861
PROFIT	10%					\$177			\$252		\$429
SUBTOTAL						\$118			\$168		\$286
						\$1,476			\$2,100		\$3,577
TOTAL THIS SHEET						\$1,476			\$2,100		\$3,577

PROJECT	Ft. McPherson & Ft. Gillem ESOS Study
LOCATION	Ft. McPherson & Ft. Gillem

DACA 21 -91 -C -0097

	OTHER
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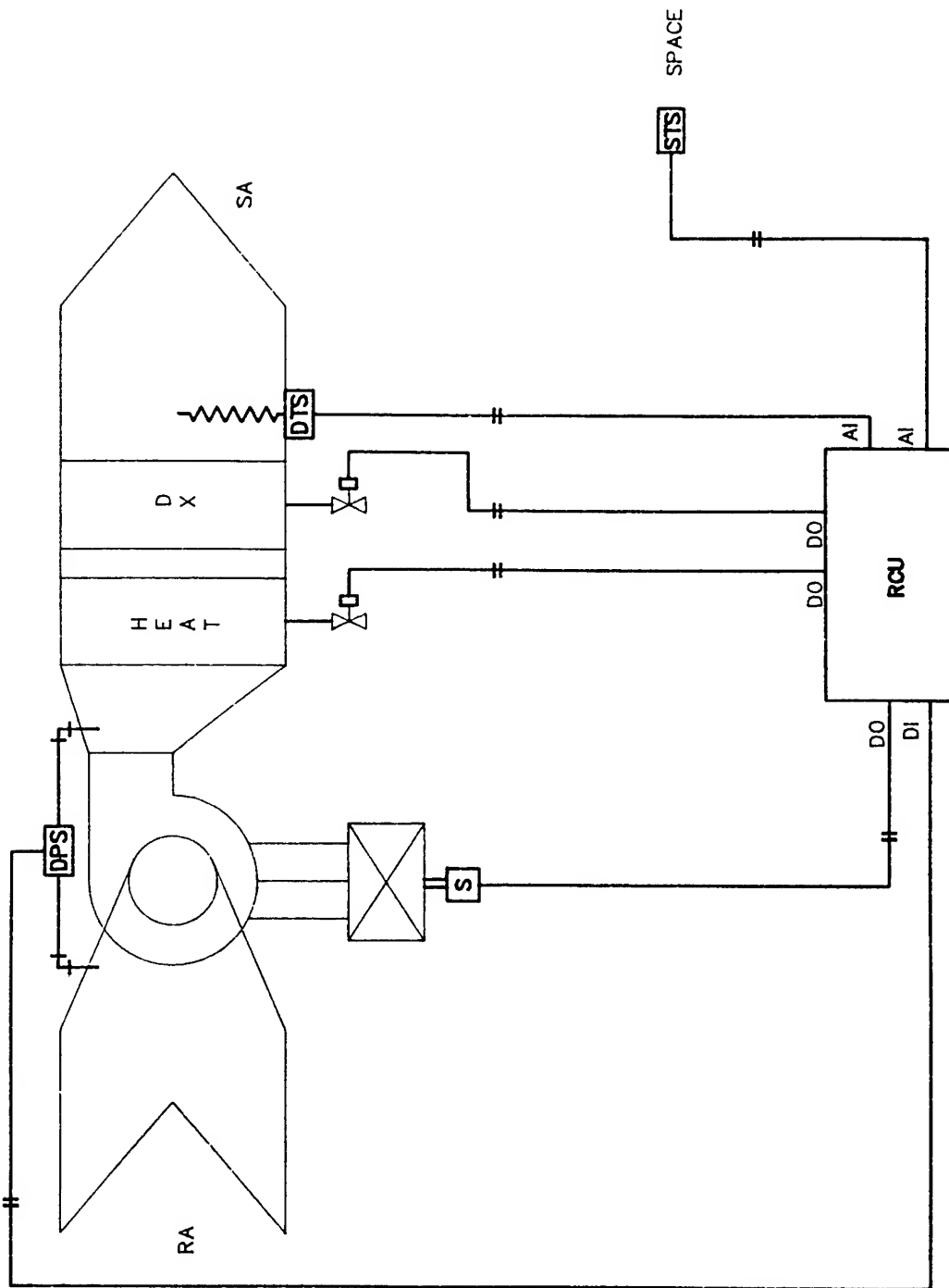
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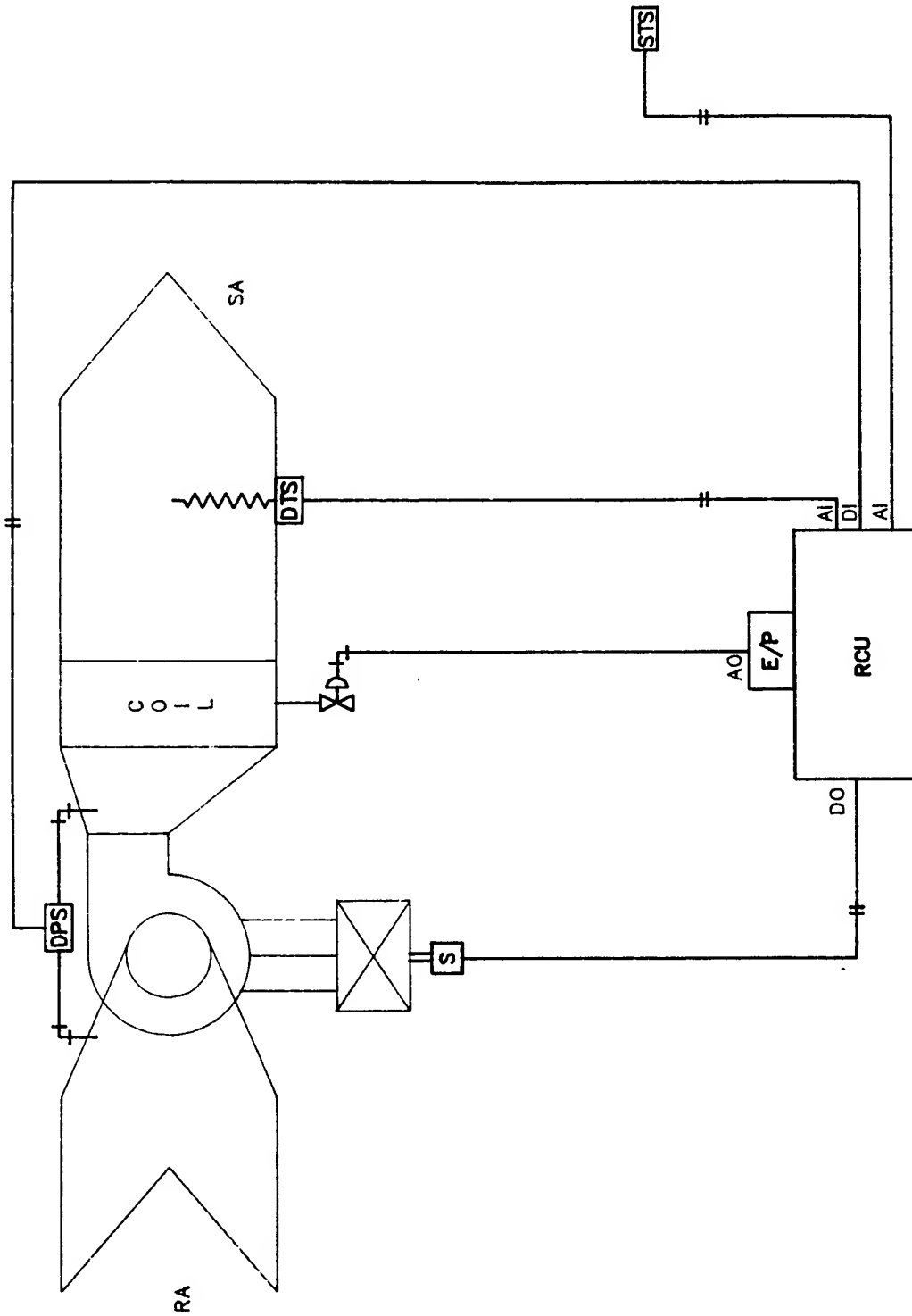
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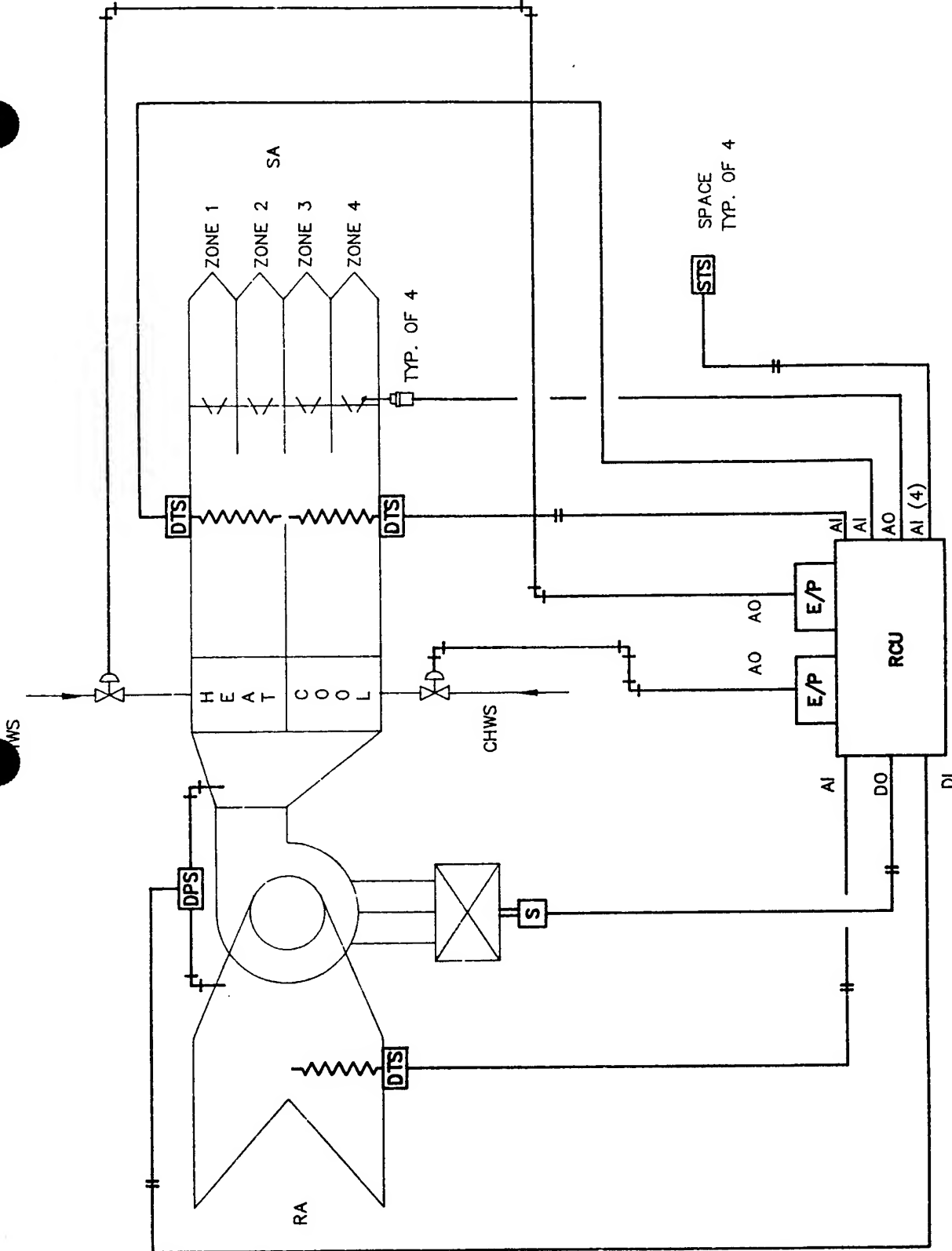
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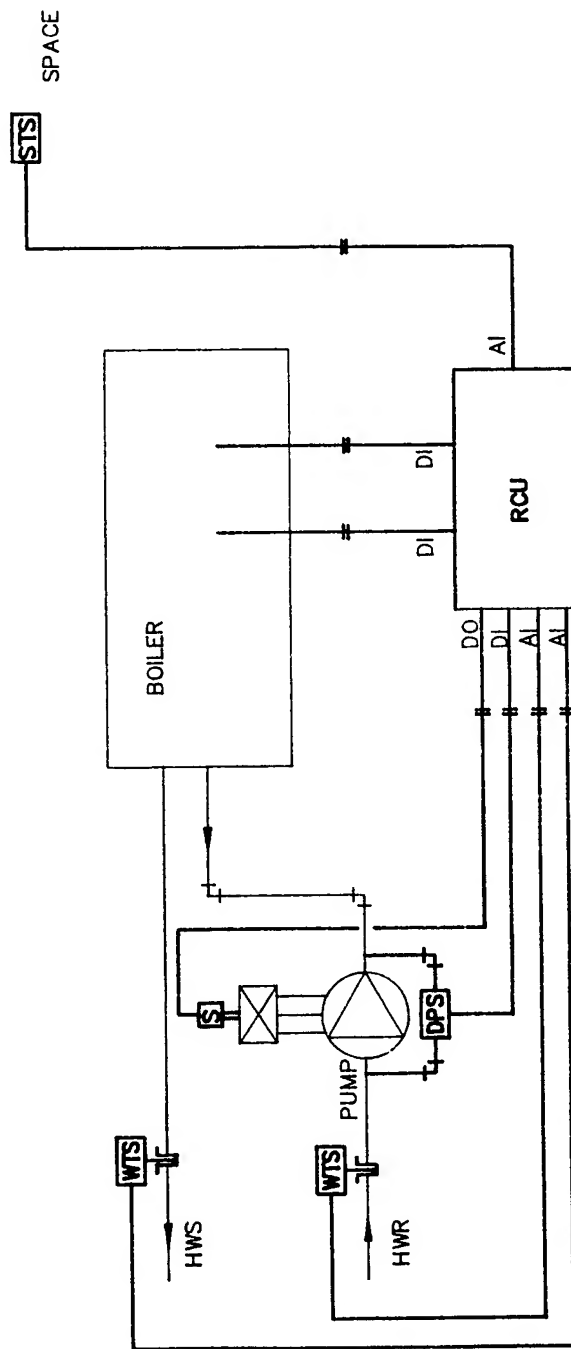
TYPICAL SINGLE ZONE AHU



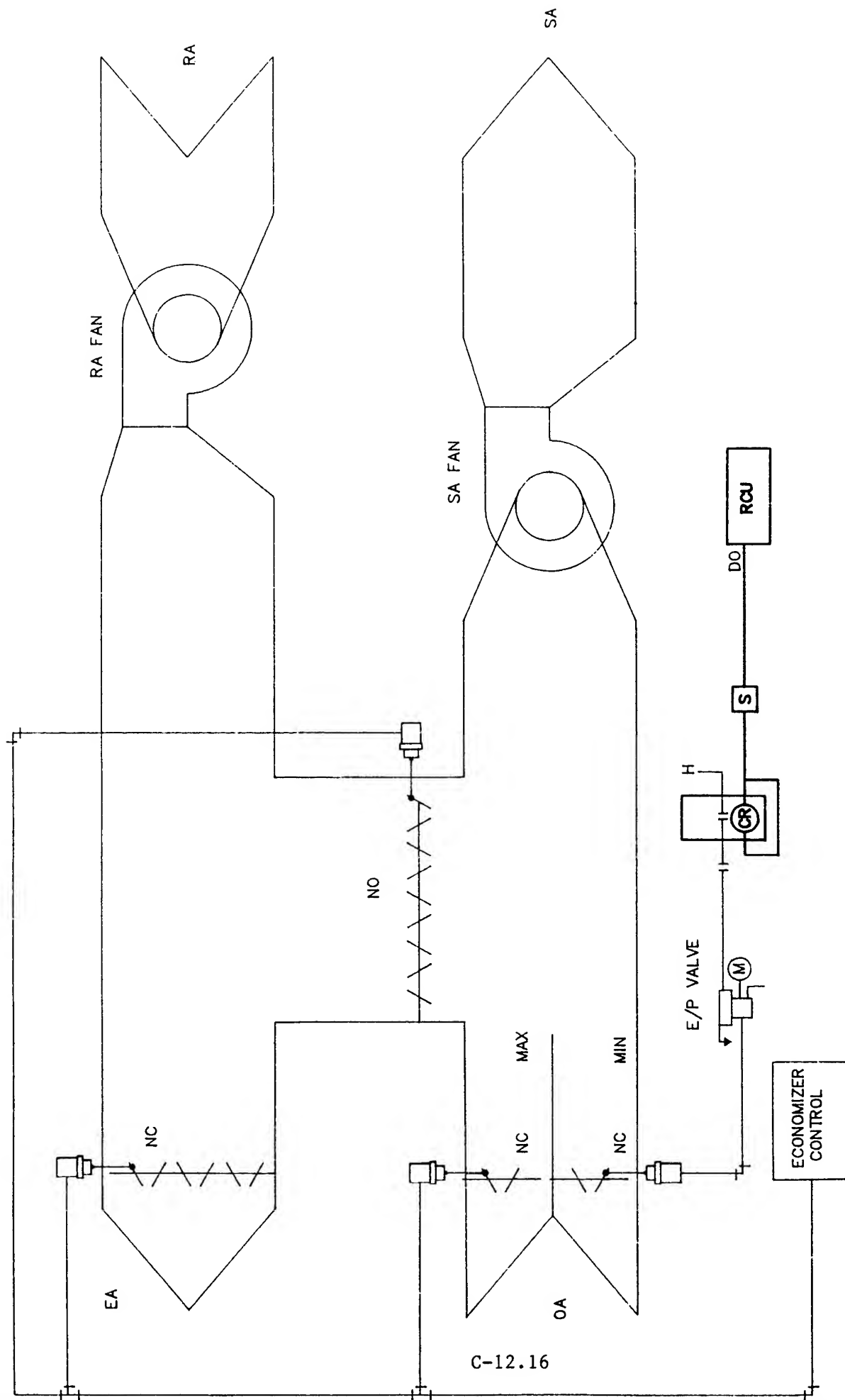
TYPICAL AHU
 BLDGS. 184, 60, 56, 58, 101, 358, 500 & 514



TYPICAL MULTIZONE AHU
BLDGS. 181 & 246



TYPICAL HW BOILER
BLDGS. 184 & 246



VAV — BUILDING 200

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB FT. MCPHERSON/GILLEM ESOS STUDY

EMC#3105.000

SHEET NO. _____ OF _____

CALCULATED BY CEL DATE 7/21/92

CHECKED BY _____ DATE _____

SCALE _____

LABOR SAVINGS:

An estimated 6 hours per year labor (non-energy) savings were taken due to a reduction in temperature (too hot-too cold) related services calls.

(6 hours per year per building) x \$21.16 per hour = \$127 per year per building

APPENDIX C-13
THERMAL STORAGE

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: THERMAL STORAGE

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/20/92
FILE: ICE.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG
INCREMENTAL ELECTRIC COST	\$0.0255 kWh	11.11 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	10.59 UPW
ECONOMIC LIFE		15 YRS

BUILDING NUMBER	FLOOR AREA (ft ²)	ICE CHILLER SIZE (TONS)	REQD STORAGE SIZE (TON-HRS)	ACTUAL STORAGE SIZE (TON-HRS)	STORAGE COST (\$)	ICE CHILLER COST (\$)	LABOR & MATERIAL COST (\$)	TOTAL COST (\$)
101	120,182	120	751	760	30000	64675	219000	313675

BUILDING NUMBER	FLOOR AREA (FT ²)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST	SIR	SIMPLE PAYBACK (YRS)
101	120,182	126	(39,069)	0	(133)	(\$996)	\$12,935	\$0	\$11,939	\$349,748	0.4	29.3

JOB Ft. McPherson / Ft. Gillem ESOS Study

EMC # 3105.000

SHEET NO. _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

ECO 13

G101

Floor Area = 120,182 ft²

Tank Capacity = 751 ton*hrs

Chiller Capacity = 125 tons

Demand Savings = 126 kw

Electricity Used = 39,069 kwh/yr

M 060

Floor Area = 20,856 ft²

Tank Capacity = 111 ton*hrs

Chiller Capacity = 20 tons

Demand Savings = 22 kw

Electricity Used = 9399 kwh/yr

M 170/171

Floor Area = 35,398 ft²

Tank Capacity = 248 ton*hrs

Chiller Capacity = 45 tons

Demand Savings = 60 kw

Electricity Used = 16,246 kwh/yr

M 500

Floor Area = 27,466 ft²

Tank Capacity = 205 ton*hrs

Chiller Capacity = 35 tons

Demand Savings = 46 kw

Electricity Used = 13,122 kwh/yr

HAYNES TRANE

6654 Greenwood Plaza Blvd.
Englewood, Colorado 80111-2388
303/779-0787
303/779-0714 (FAX)

DATE: 4/12/92

TIME: 11:30

Please transmit to Facsimile Number: ~~956~~ 985-2527

Please deliver to: DENNIS JONES

Total number of pages being sent: 4 (including this page)

Notes: DENNIS -

THESE ARE MY BEST ESTIMATES!

From: ROGER

If you do not receive all pages, please call 779-0787

TRANE

**TRANE™**

PROPOSAL

The Trane Company
A Division of
American Standard Inc.

TRANE COMPANY
5654 GREENWOOD PLAZA BLVD.
ENGLEWOOD, COLORADO 80111-2385

Customer	Number	Date
EMC ENGINEERS FAX NO:	ATLANTA	4/10/92
ATTN: DENNIS JONES	Job Name	FORT MCPHERSON

Engineer
EMC ENGINEERS

Delivery Terms
FOB: FACTORY FREIGHT ALLOWED
Terms of Payment
NET: 30 DAYS

BUILDING 181 BUDGET

ITEM: A QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER
TAG (S):
40 TON

- > 40 TON A/C COLD GENERATOR
- > ICE MAKING CONTROL MICROPROCESSOR
- > UL LISTED
- > PRESSURE GAUGES
- > FLOW SWITCH
- > CONTROL POWER TRANSFORMER

ITEM: B QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS
TAG (S):

- > QTY: 2 - MODEL 1190 TANKS
- > SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS A TO B \$ 115,000

Effective March, 1987, price increase terms will be administered as follows:
Prices stated in this proposal are firm provided that notification of release for immediate
production and shipment is received at the factory not later than five months from order
receipt. If such release is received later than five months from order receipt date but
within eight months of order receipt date, prices will be increased a straight 1.0 percent
(not compounded) for each one-month period (or part thereof) beyond the five-month firm

price period up to the date of receipt of such release. If such release is not received within
eight months after date of order receipt, the prices are subject to renegotiation or at the
Company's option, the order will be cancelled. If for any reason Buyer delays shipment
after release, prices are subject to increase as stated on the reverse side hereof.

Prices do not include taxes. See reverse side for terms and conditions of sale upon
which this proposal is based.

TRANE

PROPOSAL

The Trane Company
A Division of American Standard Inc.

Number ATLANTA

Page 2

BUILDING 184 BUDGET

ITEM: C QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER
TAG (S):
50 TON

- > 50 TON A/C COLD GENERATOR
- > ICE MAKING CONTROL MICROPROCESSOR
- > UL LISTED
- > PRESSURE GAUGES
- > FLOW SWITCH
- > CONTROL POWER TRANSFORMER

ITEM: D QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS
TAG (S):

- > QTY: 2 - MODEL 1190 TANKS
- > SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS C TO D \$ 123,000

BUILDING GT6 BUDGET

ITEM: E QTY: 1 DESCRIPTION: TRANE AIR COOLED CHILLER
TAG (S):
40 TON

- > 40 TON A/C COLD GENERATOR
- > ICE MAKING CONTROL MICROPROCESSOR
- > UL LISTED
- > PRESSURE GAUGES
- > FLOW SWITCH
- > CONTROL POWER TRANSFORMER

C-13.5

ITEM: F QTY: 2 DESCRIPTION: CALMAC ICE STORAGE TANKS
TAG (S):



TRANE

PROPOSAL

The Trane Company
A Division of American Standard Inc.

Number ATLANTA

Page 3

- > QTY: 2 - MODEL 1190 TANKS
- > SYTEM INSTALLATION, PIPING, STARTUP

TOTAL NET PRICE ITEMS E TO F \$ 115,000

State and Local taxes are not included in above price

RESPECTFULLY SUBMITTED,

RC7H

ROGER C. HUBERT
SALES ENGINEER

PROJECT: FORT MCPHERSON

ANALYSIS BY: DAN McGUINNESS

ROGER HUBERT - HAYNES TRANE
5654 GREENWOOD PLAZA BLVD.
ENGLEWOOD, CO 80111-2385
(303) 779-0787

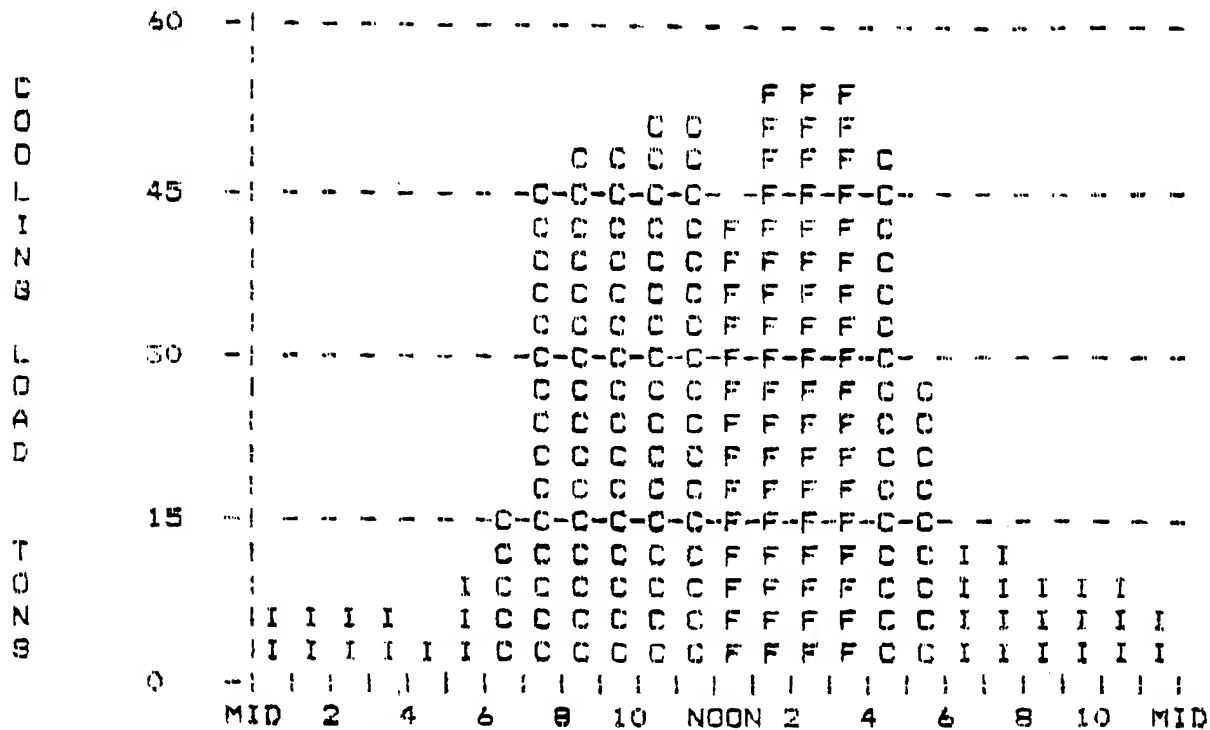
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04-10-1992

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DESIGN DAY LOAD DATA							
HOUR	LOAD	TYPE	CHILL %	HOUR	LOAD	TYPE	CHILL %
1	6.30	I	65.0	13	42.20	F	0.0
2	5.60	I	65.0	14	54.10	F	0.0
3	5.00	I	65.0	15	53.70	F	0.0
4	4.60	I	65.0	16	54.60	F	0.0
5	4.40	I	65.0	17	48.20	P	100.0
6	8.90	I	65.0	18	28.00	P	100.0
7	16.30	P	100.0	19	11.80	I	65.0
8	46.40	P	100.0	20	11.00	I	65.0
9	48.10	P	100.0	21	9.90	I	65.0
10	49.50	P	100.0	22	8.80	I	65.0
11	50.80	P	100.0	23	7.80	I	65.0
12	50.20	P	100.0	24	6.90	I	65.0



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HOUR OF DAY

LEVL0AD TANK MODEL	1190
DESIGN LOAD	54.6
SYSTEM SUPPLY TEMPERATURE (DEG F)	45
SYSTEM RETURN TEMPERATURE (DEG F)	55
DEFAULT CHILLER COOLING CAPACITY (% OF NOMINAL)	100
DEFAULT CHILLER ICEMAKING CAPACITY (% OF NOMINAL)	65
NUMBER OF COOLING HOURS	12
NUMBER OF ICE-MAKING HOURS	12
TOTAL COOLING LOAD (TONS-HRS)	633.1

NOM CHLR TONS	COOL CAP TONS	ICE CAP TONS	STRG DIV	ESTMTD TON HOURS	STRG INLET DEG F	STRG OUT DEG F	PEAK STRG TONS	MIN # TANKS	MAX # TANKS
42.67	42.67	27.73	0.37	129.00	55.00	45.00	54.60	1.87	1.87
60.00	60.00	39.00	0.31	128.00	55.00	45.00	54.60	1.60	2.95

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TANK DISCHARGE PROFILE

HOUR & TYPE	TONS PER TANK	INLET TEMP DEG.F	OUTLET TEMP DEG.F	PERCENT TANK DISCH.	OUT OF RANGE
13 F	21.1	52.7	45.0	11.1	
14 F	27.0	54.9	45.0	25.3	
15 F	26.9	54.8	45.0	39.5	
16 F	27.3	55.0	45.0	53.8	

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- FLOW ANALYSIS - 60 TON CHILLER - 2 MODEL 1190 STORAGE TANKS

CHG dt	CHG GPM	GPM/TANK	dp (PSI)	AVG LCWT	MIN LCWT
3.0	331.5	165.8	****	****	****
4.0	248.6	124.3	****	****	****
5.0	198.9	99.4	19.2	23.7	20.7
6.0	165.8	82.9	14.1	23.0	20.3
7.0	142.1	71.0	10.9	22.4	19.9
8.0	124.3	62.2	8.8	21.7	19.5
9.0	110.5	55.3	7.3	21.0	19.1
10.0	99.4	49.7	6.2	20.2	18.7

DIS dt	DIS GPM	GPM/TANK	dp (PSI)
8.0	174.0	87.0	12.6
9.0	154.7	77.3	10.4
10.0	139.2	69.6	8.7
11.0	126.6	63.3	7.5
12.0	116.0	58.0	6.5
13.0	107.1	53.5	5.7
14.0	99.4	49.7	5.1
15.0	92.8	46.4	4.6

PROJECT: FORT MCPHERSON

ANALYSIS BY: DAN MCGUINNESS

ROGER HUBERT - HAYNES TRANE
5654 GREENWOOD PLAZA BLVD.
ENGLEWOOD, CO 80111-2385
(303) 779-0787

FILE #DENO05CD
BLDG. GT6

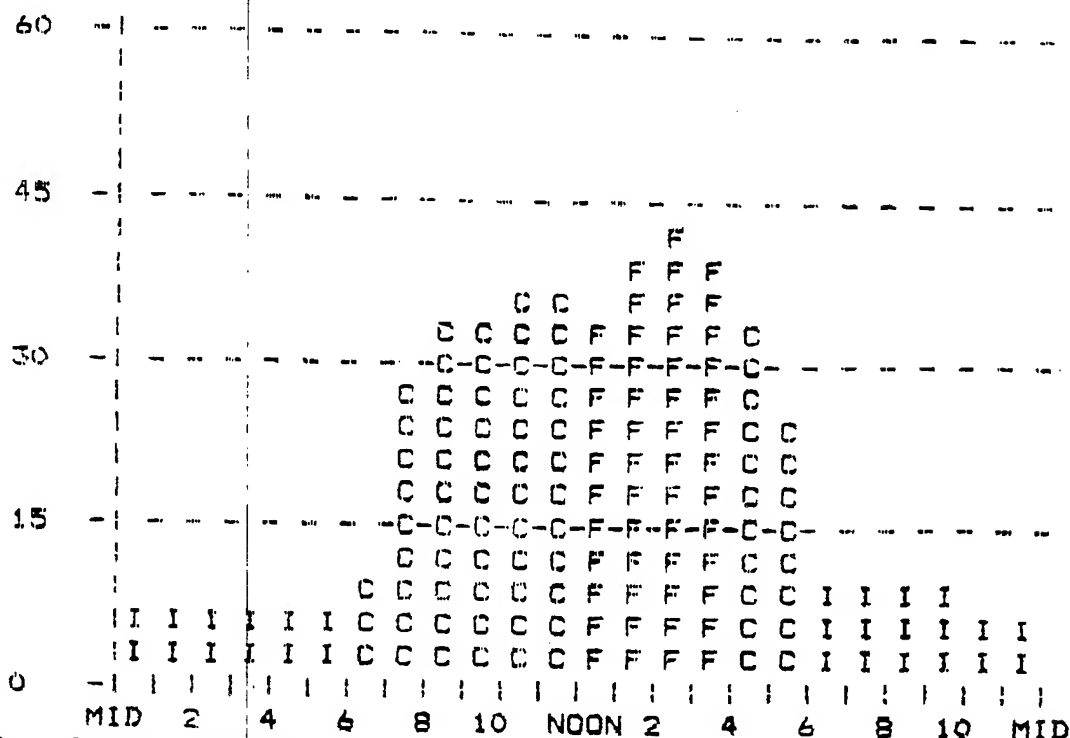
04-10-1992

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DESIGN DAY LOAD DATA							
HOURL	LOAD	TYPE	CHILL %	HOURL	LOAD	TYPE	CHILL %
1	7.20	I	65.0	13	32.80	F	0.0
2	6.40	I	65.0	14	39.40	F	0.0
3	5.90	I	65.0	15	41.30	F	0.0
4	5.50	I	65.0	16	40.30	F	0.0
5	5.40	I	65.0	17	34.50	P	100.0
6	7.40	I	65.0	18	23.20	P	100.0
7	10.20	P	100.0	19	10.10	I	65.0
8	26.70	P	100.0	20	9.20	I	65.0
9	32.10	P	100.0	21	8.50	I	65.0
10	34.00	P	100.0	22	7.90	I	65.0
11	35.00	P	100.0	23	7.40	I	65.0
12	35.70	P	100.0	24	7.00	I	65.0

COOLING
LOAD
TONS



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HOUR OF DAY

LEULOAD TANK MODEL
DESIGN LOAD 1190
SYSTEM SUPPLY TEMPERATURE (DEG F) 41.3
SYSTEM RETURN TEMPERATURE (DEG F) 45
DEFAULT CHILLER COOLING CAPACITY (% OF NOMINAL) 55
DEFAULT CHILLER ICEMAKING CAPACITY (% OF NOMINAL) 100
NUMBER OF COOLING HOURS 65
NUMBER OF ICE-MAKING HOURS 12
TOTAL COOLING LOAD (TONS-HRS) 12
473.1

NOM. CHLR TONS	COOL CAP TONS	ICE CAP TONS	STRG DIV	ESTMTD TON HOURS	STRG INLET DEG F	STRG OUT DEG F	PEAK STRG TONS	MIN # TANKS	MAX # TANKS
32.28	32.28	20.98	0.33	128.30	55.00	45.00	41.30	1.28	1.28
65.00	65.00	42.25	0.31	128.30	55.00	45.00	41.30	1.20	3.27

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CHILLER UPSTREAM - SERIES FLOW
 SYSTEM SUPPLY TEMPERATURE = 45.0
 SYSTEM RETURN TEMPERATURE = 55.0
 FLOW (GPM) - DISCHARGE = 105.3
 DELTA P (PSI) - DISCHARGE = 5.9

DESIGN DAY SYSTEM ANALYSIS
 NOMINAL CHILLER SIZE = 65.0
 NUMBER OF TANKS = 2 MODEL 1190
 DESIGN LOAD = 41.3 TONS
 CHARGE = 105.3
 CHARGE = 6.7

HOURL	&	LOAD	CHLR	STRG	TANK	TN-HRS	TN-HRS/	%	CHLR	STRG	REQD	AVLB	RET	GPM	PD
TYPE	TONS	TONS	TONS	TONS	TONS	TOTAL	TANK	CHARGE	TEMP	TEMP	MIN	TEMP	TEMP	PER	FB
1	I	7	42	35	17.5	238	119.2	62.7	21.8	30.3	30.3	32.0	52.7	6.8	
2	I	6	42	36	17.8	274	137.1	72.2	20.9	29.6	29.6	31.1	52.7	6.9	
3	I	6	42	36	18.2	311	155.3	81.7	19.8	28.6	28.6	30.1	52.7	6.9	
4	I	5	42	37	18.4	347	173.7	91.4	18.6	27.5	27.5	28.8	52.7	6.9	
5	I	5	18	13	6.3	360	180.0	94.7	23.2	26.3	26.3	27.6	52.7	6.9	
6	I	7	7	0	0.0	360	180.0	94.7	****	****	****	****	52.7	****	
7	P	10	10	0	0.0	360	180.0	94.7	45.0	45.0	32.0	47.5	0.0	****	
8	P	27	27	0	0.0	360	180.0	94.7	45.0	45.0	32.0	51.5	0.0	****	
9	P	32	32	0	0.0	360	180.0	94.7	45.0	45.0	32.0	52.8	0.0	****	
10	P	34	34	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.2	0.0	****	
11	P	35	35	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.5	0.0	****	
12	P	36	36	0	0.0	360	180.0	94.7	45.0	45.0	32.0	53.6	0.0	****	
13	P	33	0	-33	-16.4	327	163.6	86.1	52.9	45.0	32.8	52.9	20.7	1.9	
14	P	39	0	-39	-19.7	288	143.9	75.7	54.5	45.0	33.7	54.5	24.1	2.2	
15	P	41	0	-41	-20.7	247	123.3	64.9	55.0	45.0	34.6	55.0	25.8	2.3	
16	P	40	0	-40	-20.2	206	103.1	54.3	54.8	45.0	35.5	54.8	26.7	2.4	
17	P	34	34	0	0.0	206	103.1	54.3	45.0	45.0	32.0	53.4	0.0	****	
18	P	23	23	0	0.0	206	103.1	54.3	45.0	45.0	32.0	50.6	0.0	****	
19	I	10	42	32	16.1	32	16.1	8.5	24.1	31.9	31.9	34.3	52.7	6.7	
20	I	9	42	33	16.5	65	32.6	17.2	23.8	31.8	31.8	34.0	52.7	6.8	
21	I	8	42	34	16.9	99	49.5	26.0	23.5	31.7	31.7	33.7	52.7	6.8	
22	I	8	42	34	17.2	133	66.6	35.1	23.2	31.5	31.5	33.4	52.7	6.8	
23	I	7	42	35	17.4	168	84.1	44.2	22.8	31.2	31.2	33.0	52.7	6.8	
24	I	7	42	35	17.6	203	101.7	53.5	22.3	30.8	30.8	32.5	52.7	6.8	

TANK DISCHARGE PROFILE

HOUR & TYPE	TONS PER TANK	INLET TEMP DEG. F	OUTLET TEMP DEG. F	PERCENT TANK DISCH.	OUT OF RANGE
13 F	16.4	52.9	45.0	8.6	
14 F	19.7	54.5	45.0	19.0	
15 F	20.6	55.0	45.0	29.9	
16 F	20.1	54.8	45.0	40.5	

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- FLOW ANALYSIS - 65 TON CHILLER - 2 MODEL 1190 STORAGE TANKS

CHG dT	CHG GPM	GPM/TANK	dP (PSI)	AVG LCWT	MIN LCWT
3.0	359.1	179.6	****	****	****
4.0	269.3	134.7	****	****	****
5.0	215.5	107.7	22.0	23.3	20.2
6.0	179.6	89.8	16.1	22.6	19.8
7.0	153.9	77.0	12.4	22.0	19.5
8.0	134.7	67.3	10.0	21.3	19.0
9.0	119.7	59.9	8.2	20.6	18.7
10.0	107.7	53.9	7.0	19.9	18.3

DIS dT	DIS GPM	GPM/TANK	dP (PSI)
8.0	131.6	65.8	8.0
9.0	117.0	58.5	6.6
10.0	105.3	52.7	5.6
11.0	95.7	47.9	4.8
12.0	87.8	43.9	4.2
13.0	81.0	40.5	3.8
14.0	75.2	37.6	3.4
15.0	70.2	35.1	3.1

TYPICAL ICE STORAGE DESIGN

I. Determine type of storage system.

The type of storage system, e.g., partial or full storage*, chiller or ice priority, with or without eutectic salts, etc., is generally determined by economic and site considerations, such as utility rate structures, acceptable payback, retrofit vs. new construction and available space, to name a few.

Since chiller sizing and tank selection are straightforward for full storage, we will choose a partial storage, chiller priority system for our example.

II. Establish a system configuration.

There are three basic system designs:

1. *Series flow, storage upstream.* (Figure 1.) Recoverable cooling storage is maximized but chiller inlet temperature is depressed. Control strategies and piping are simplified.

2. *Series flow, chiller upstream.* (Figure 2.) Chiller operates at a very high capacity and efficiency. Recoverable storage is decreased slightly. Also provides simplified control and piping.

3. *Parallel flow.* (Figure 3.) Both chiller and storage receive the benefit of high return temperature liquid. Chiller operates at high capacity and efficiency and recoverable storage is maximized. System pressure drop is reduced although controls and piping can be more complex than for series systems.

For our example, assume a series flow system, chiller upstream, with 45F supply and 60F return temperatures.

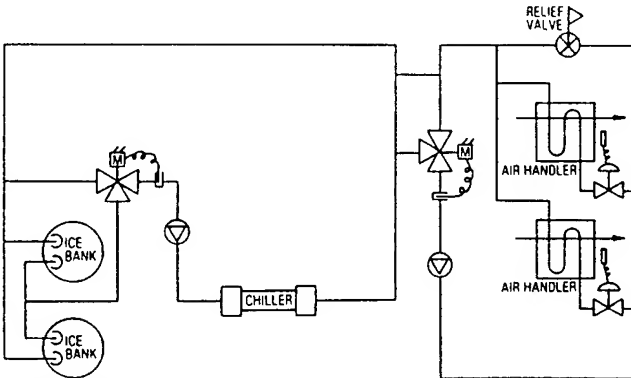


Figure 1. Series flow, storage upstream.

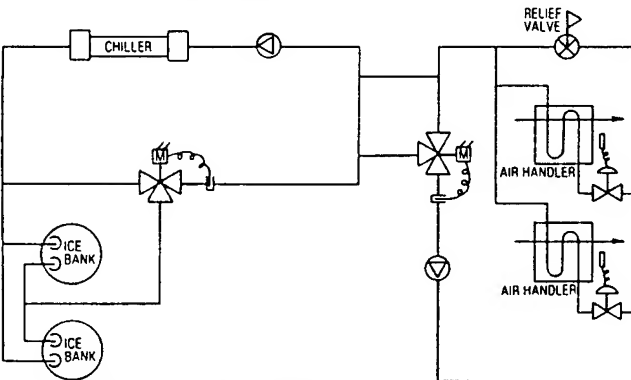


Figure 2. Series flow, chiller upstream.

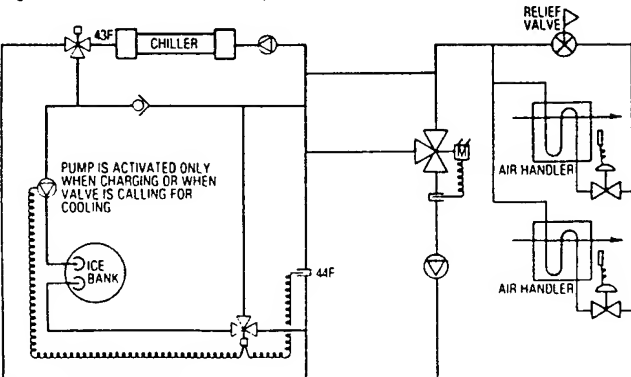


Figure 3. Parallel flow.

III. Determine System Ton-Hours (STH).

Required ton-hours for the daily cooling period are calculated as follows:

Where Design Load = 1000 tons, Diversity = .85, and Number of Cooling Hours (occupied period + precool hours) = 10.

$STH = \text{Design Load} \times \text{Diversity} \times \text{Number of Cooling Hours}$

$STH = 1000 \text{ tons} \times .85 \times 10 \text{ hours} = 8500 \text{ ton-hours}$

Alternatively, if hourly building loads are available from a building load profile, as in Figure 4, these can be summed up to give total System Ton-Hours.

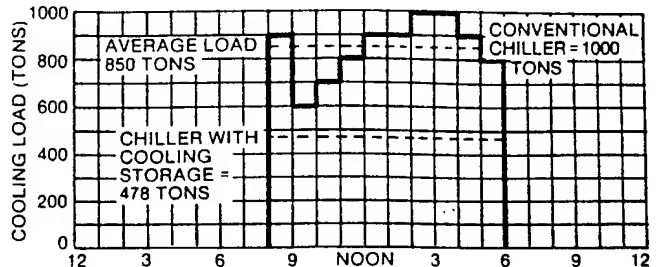


Figure 4. Building Load Profile.

IV. Determine Nominal Chiller Size (NCS).

All chiller capacities are referenced to standard conditions. Therefore, the chiller tonnage calculated for this section is the required capacity at standard rating conditions, not ice making conditions. Basically, we are looking for the chiller whose total capacity—daytime cooling + ice making—will equal the total system ton-hours required.

1. From manufacturer's data, determine the chiller's capacity at ice making condition (usually about 25F LCWT and 31F RCWT) as a percentage of its standard or nominal capacity (CAP_{ice}). A 1000-ton chiller that produces 650 tons at ice making conditions would be rated at .65. This is the figure we will use in the example.

2. Determine, from manufacturer's data, the chiller's capacity, as a percentage of its nominal capacity, for daytime cooling conditions (CAP_{occ}). Depending on system design, this number can be in excess of 1 or, for severe design conditions, may be slightly less than 1. For the example, a value of 1 will be used, which means that a 1000-ton nominal chiller will provide 1000 tons on a design day.

3. Determine the number of hours available to make ice. This will be dependent on the building's unoccupied period, utility off-peak periods, on-peak/off-peak rate differentials, etc. We will assume 12 hours for ice making.

4. Calculate minimum Nominal Chiller Size (NCS):

$$NCS = \frac{\text{System Ton-Hours}}{(\text{CAP}_{ice} \times \text{Icemaking Hrs.}) + (\text{CAP}_{occ} \times \text{Cooling Hrs.})}$$

$$NCS = \frac{8500 \text{ Ton-Hours}}{(.65 \times 12) + (1 \times 10)} = 477.5 \text{ Tons}$$

For Full Storage, use 0 for Cooling Hours in the equation above.

V. Calculate the required number of Ice Banks.

The storage tanks must first be rated for the particular system conditions. This procedure is demonstrated on the bottom of page 3 in the "K-Factor" example for a *Parallel Flow* system. For our *Series Flow* example, we must calculate the temperature leaving the chiller and entering the tanks. At 1000 tons and a load Δt of 15 degrees (60F - 45F), the system flow for peak conditions will be:

$$GPM = \frac{\text{Tons} \times 25.5}{\Delta t} = \frac{1000 \times 25.5}{15} = 1700$$

The chiller Δt will be:

$$\Delta t = \frac{\text{Tons} \times 25.5}{GPM} = \frac{477.5 \times 25.5}{1700} = 7.16F$$

The temperature of the fluid entering the tanks will therefore be 60F - 7.16F = 52.84F. The leaving temperature will be 45F.

For 52.84 inlet and 45F outlet temperatures and a .85 diversity, the storage tanks (Model 1190) will deliver 86% (.86) of their nominal storage at a 19 ton rate.

The required storage is equal to the system ton-hours less the contribution of the chiller during the cooling period. The required

storage is then divided by the modified storage tank's capacity to achieve the proper number of tanks. Assume Model 1190 LEVLOAD Ice Banks, which are nominally rated for 190 ton-hours.

$$\text{Number of Ice Banks} = \frac{\text{STH} - (\text{NCS} \times \text{Cooling Hours})}{\text{Ton-Hours Tank} \times \text{K-Factor}}$$

$$\text{Number of Ice Banks} = \frac{8500 - (477.5 \times 10)}{190 \times .86} = 22.8 \text{ (Use 23 tanks)}$$

For Full Storage, use 0 for Cooling Hours in the equation above.

VI. Check results.

1. Compare chiller capacity to load curve. These formulas assume that the chiller is operating at full load for the entire day. If the building load drops below chiller capacity during the cooling period, the chiller will unload and the total contribution of the chiller will be reduced. Under these circumstances the chiller will be undersized, although this is generally not the case. For the present example, the minimum building load is 600 tons (see Figure 4) and the calculated chiller size will be adequate.

2. Verify assumed charge temperatures. Using the charging flow rate and ice making chiller capacity, we can determine the actual required Average Charging Brine Temperature (ACBT), which is the same as the LCWT of the chiller, from the charge curves and compare to the assumption in Step IV. If the charging time is unusually short, you may find that the ACBT has been depressed and your assumption of chiller ice making capacity may have to be revised.

After correcting the pump capacity for the fluid conditions at ice making temperatures (let's say 1600 GPM for our system), a charging Δt can be calculated:

$$\text{Chiller capacity} = 477.5 \times .65 = 310.4 \text{ tons}$$

$$\Delta t = \frac{310.4 \times 25.5}{1600} = 5\text{F}$$

Divide the assumed chiller capacity by the number of tanks to calculate a tons/tank charge rate:

$$\text{Tons/tank} = \frac{310.4 \text{ tons}}{23 \text{ tanks}} = 13.5$$

From the Model 1190 Charge Curve (page 12) at 13.5 tons/tank and a 5F Δt , find an ACBT of 25 2F, which agrees with our original assumption. The Minimum Charging Brine Temperature (at full charge) is 22 3F.

3. Check for excessive discharge rates. The storage adjustment factor (K-Factor) is calculated to allow for normally encountered variations in discharge rate (peak loads). However, if unusually large variations in peak load occur for short periods, the storage outlet temperature may rise above design. (Consult Calmac in these circumstances.) In our example, we used a K-Factor of .86 and a 19 ton discharge rate. However, the peak discharge rate per tank of our system is 22.7 tons [(1000 tons - 477.5 tons) \div 23 tanks] at 3:00 P.M. Since this is higher than 19 tons we must determine the average discharge rate *per tank* for the interval from peak to the final hour:

$$\frac{(1000 \text{ T-H} + 900 \text{ T-H} + 800 \text{ T-H}) - (477.5 \text{ Tons} \times 3 \text{ Hrs.})}{3 \text{ Hrs.} \times 23 \text{ Tanks}} = 18.4 \text{ Tons}$$

Since this is less than 19 tons, the design is valid.

4. Check Ice Bank pressure drop. Maximum storage pressure drop is generally encountered during the charge period.

Using the example:

$$\text{GPM/tank} = \frac{1600 \text{ GPM}}{23 \text{ tanks}} = 69.6$$

From the pressure drop curves (page 10), find storage pressure drop of 10.5 psi.

*See Glossary on last page for explanations of unfamiliar terms.

K-FACTOR EXAMPLE

Design Conditions:

1. Occupied Hours	10
2. Precool Hours	2
3. Diversity (Average Load \div Peak Load)	.75
4. LEVLOAD Model	1100
5. Storage Inlet Temp. (F)	60
6. Maximum Temp. from Storage (F)	45

Cooling Hours = Occupied Hours + Precool Hours

Adjusted Discharge Hours = Diversity \times Cooling Hours

Cooling Hours = 10 + 2 = 12

Hours of Discharge = .75 \times 12 = 9.0

1. On the Model 1100 Performance Discharge Curve for a CONSTANT INLET TEMP. = 60F, locate Hours of Discharge (9.0)

along the horizontal axis.

2. Move vertically to the Blended Outlet Temperature point of 45 degrees. (Point A on Curve).

3. From Point A, move horizontally to the left to read the amount of total Ton-Hours available (90 TON-HOURS).

4. Move horizontally to the right to find the K-Factor which is used in our equations for designing the systems (.90).

5. Following a line up and to the right, read the Discharge Rate at which the tank was discharged for the 9 hours (10.0 TONS).

6. The flow rate for a one-tank system (GPM-sys) is calculated from the equation at bottom of Curve Sheet:

$$\text{GPM} = 25.5 \times 10 \text{ tons} / 15\text{F} = 17$$

Model 1100 EXAMPLE 60F

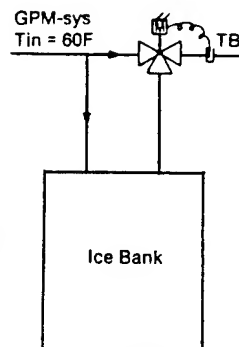
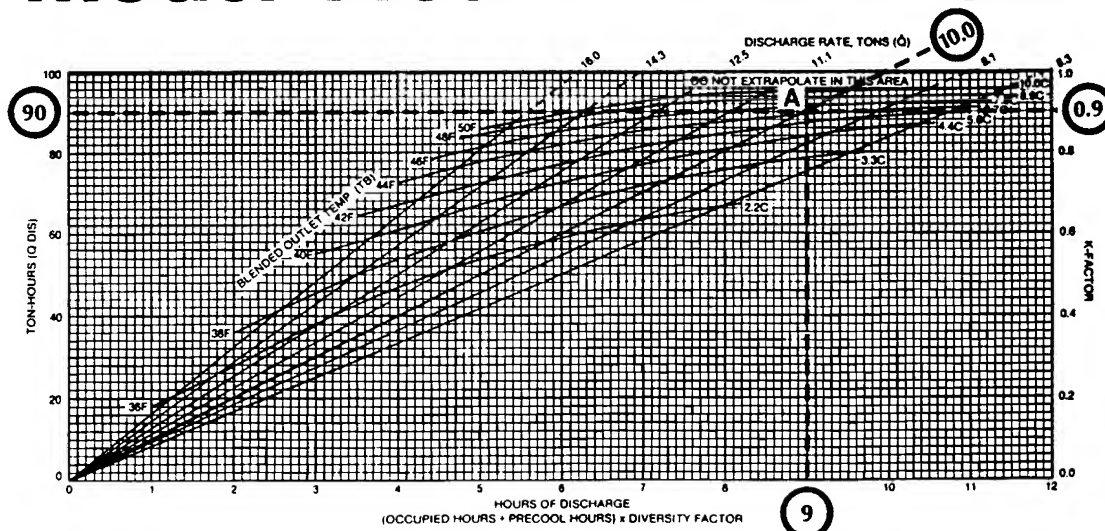


Figure 5. Blended outlet temperature



COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097

☒ CODE A ☐ CODE B ☐ CODE C
☐ OTHER

EFFECTIVE PRICING
DATE APR 92

DRAWING NO.

DATE PREPARED
22-Apr-92

SHT OF

CHECKED BY CEL

SHIPPING

ESTIMATOR RMG

TOTAL

EQUIPMENT

Unit Price Cost

LABOR

MH/ Unit

Quantity

No. Of Units

Unit Meas

Total Hrs

Unit Price

Cost

Unit Price Cost

Unit Wt

TASK DESCRIPTION

AIR COOLED CHILLER (50 TON)

ICE STORAGE TANKS

SYSTEM INSTALLATION, PIPING, STARTUP

SUBTOTAL

OVERHEAD, BOND

PROFIT

COST SUB-TOTAL

CONTINGENCY

TOTAL

DA FORM 5416-R, APR 85

APPENDIX C-14.1
LOADING DOCK SEALS

LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) STUDY: GECO15
 LCCID 1.062
 INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3
 PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
 FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-14 LOADING DOCK SEALS
 ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	101808.
B. SIOH	\$	5600.
C. DESIGN COST	\$	6109.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	113517.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	377.	\$ 2820.	11.11	31334.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	4234.	\$ 19773.	14.45	285717.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		4611.	\$ 22593.		\$ 317051.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	0.
(1) DISCOUNT FACTOR (TABLE A)	10.59	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	0.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	0.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	104627.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))	\$	22593.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	\$	317051.
6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)=	2.79	
(IF < 1 PROJECT DOES NOT QUALIFY)		
7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4	5.02	

**LOADING DOCK SEALS SAMPLE CALCULATION, ECO #14
BUILDING 512**

Given:

Building 207 has 5 truck loading dock doors.

Building 512 has 6 truck loading dock doors.

Gas Savings	= 336 MBtu / 5 doors	- from Bldg 207 simulation
Electric Savings Factor	= 8,778 kWh / 5 doors	- from Bldg 207 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 207 simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Peak Demand Savings:

= 0.0 kW

Annual Energy Savings:

- Gas: ((336 MBtu / 5 doors) * 6 doors) = 403 MBtu
- Electric: ((8,778 kWh / 5 doors) * 6 doors) = 10,534 kWh

Annual Cost Savings:

$(403 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (10,534 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$2,153 / \text{yr}$

Estimated Construction Cost:

\$1,616 / door

$(\$1,616 * 6 \text{ doors}) = \$9,696$

$\$9,696 + (\$9,696 * .055 \text{ SIOH}) + (\$9,696 * .06 \text{ DESIGN}) = \$10,811$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: LOADING DOCK SEALS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/22/92
FILE: SEALS.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

ENERGY COST			DISCOUNT FACTOR		SAVINGS FACTOR							
INCREMENTAL GAS COST			\$4.67 MBtu		14.45 UPWG							
INCREMENTAL ELECTRIC COST			\$0.0256 kWh		11.11 UPWE							
ELECTRIC DEMAND CHARGE			\$102.66 kW		10.59 UPW							
ECONOMIC LIFE			15 YRS		67.20 MBtu/door							
					1755.60 kWh/door							
					0.00 kW/door							
BUILDING NUMBER	NO. OF OVERHEAD DOORS	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
214	3	0	5,267	202	220	1,076	0	0	1,076	5,406	2.8	5.0
505	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
506	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
507	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
508	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
509	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
510	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
511	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
513	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
514	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
512	6	0	10,534	403	439	2,153	0	0	2,153	10,811	2.8	5.0
TOTAL		0	110,603	4,234	4,611	22,602	0	0	22,602	113,516	2.8	5.0

APPENDIX C-14.2
INFRARED HEATERS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)
INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-14 RADIANT HEAT
ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

STUDY: GECO15

LCCID 1.065

1. INVESTMENT

A. CONSTRUCTION COST	\$	955110.
B. SIOH	\$	52531.
C. DESIGN COST	\$	57307.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	1064948.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	5761.	\$ 43043.	11.11	478205.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	12860.	\$ 60056.	14.45	867812.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		18621.	\$ 103099.		\$ 1346017.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	10.59	\$	0.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$	0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)\$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 444186.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS\ ECONOMIC\ LIFE))$ \$ 103099.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 1346017.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.26
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) $SPB=1E/4$ 10.33

**RADIANT HEAT SAMPLE CALCULATION, ECO #14
BUILDING 512**

Given:

Gas Savings

Analysis based on "Development of Radiant Heating Economic Evaluation Methods," see attached factors page C-14.2.3

$$\begin{aligned}\text{Gas Savings Factor} &= 1,183 \text{ Mbtu per } 149,300 \text{ sq. ft} \\ &= .00790 \text{ MBtu / sq. ft.}\end{aligned}$$

Electric Savings Factor

Analysis based on computer simulation of building 207, fan electric use, see page C-20.2

$$\begin{aligned}\text{Electric Savings Factor} &= 155,220 \text{ kWh per } 149,300 \text{ sq. ft} \\ &= 1.03965 \text{ kWh / sq. ft.}\end{aligned}$$

Demand Savings Factor	= 0.0 kW	
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Peak Demand Savings:

$$(120,327 \text{ ft}^2) * (0.0 \text{ kW / UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

$$\begin{aligned}\text{- Gas:} & (120,327 \text{ ft}^2) * (0.0079 \text{ MBtu / ft}^2) = 953 \text{ MBtu} \\ \text{- Electric:} & (120,327 \text{ ft}^2) * (1.03965 \text{ kWh / ft}^2) = 125,098 \text{ kWh}\end{aligned}$$

Annual Cost Savings:

$$\begin{aligned}& (953 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (125,098 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 \\ & + .95 * 8) = \$8,200 / \text{yr}\end{aligned}$$

Estimated Construction Cost:

$$\$0.588 / \text{sq. ft.}$$

$$(120,327 \text{ ft}^2 * (0.588) = \$70,786$$

$$\$70,786 + (70,786 * .055 \text{ SIOH}) + (70,786 * .06 \text{ DESIGN}) = \$78,926$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

CLIENT CONTRACT NO.: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/02/92
FILE: RADIANT.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR	SAVINGS FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG	0.00792 MBtu/ft2
INCREMENTAL ELECTRIC COST	\$0.0255 kWh	11.11 UPWE	1.03965 kWh/ft2
ELECTRIC DEMAND CHARGE	\$102.66 kW	10.59 UPW	0.00000 kW/ft2
ECONOMIC LIFE		15 YRS	

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
207	149,300	0	155,220	1,183	1,712	9,481	0	0	9,481	97,930	1.3	10.3
214	166,920	0	173,539	1,322	1,914	10,599	0	0	10,599	109,488	1.3	10.3
400	76,623	0	79,661	607	879	4,866	0	0	4,866	50,259	1.3	10.3
401	27,455	0	28,544	217	315	1,743	0	0	1,743	18,009	1.3	10.3
505	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
506	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
507	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
508	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
509	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
510	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
511	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
512	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
513	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
514	120,327	0	125,098	953	1,380	7,641	0	0	7,641	78,926	1.3	10.3
TOTAL		0	1,687,945	12,860	18,620	103,097	0	0	103,097	1,064,948	1.3	10.3

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

EMC PROJECT: #3105.000
DATE: 09/02/92
FILE: RADIANT.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

G207

OPERATIVE TEMPERATURE	TO	65 F
BUILDING LOAD COEFFICIENT	BLC	70,320 Btu/F/hr
AVERAGE HEAT GAIN	Qg(G)	119,860 Btu/hr
CONVENTIONAL SYSTEM EFFICIENCY	Ecc(CEC)	75%
RADIANT EFFICIENCY	RAD	55%
FLOOR AREA	AF	149,300 ft2
RADIANT COMBUSTION EFFICIENCY	Ecr(CER)	85%

MONTH	NUMBER OF DAYS	CONVENTIONAL SYSTEM				RADIANT SYSTEM				HEATING ENERGY USAGE (MBtu)	HEATING ENERGY SAVINGS (MBtu)
		BASE --65 DEGREE DAYS (F-day)	OUTSIDE AIR TEMP (F)	C FACTOR [E]	CORRECTED DEGREE DAYS (F-day)	HEATING ENERGY USAGE (MBtu)	INDOOR AIR TEMP (F)	C FACTOR [J]	CORRECTED DEGREE DAYS (F-day)	HEATING ENERGY USAGE (MBtu)	
	Nm	[C]	Tosa [D]	C, Eq-13 [E]	DDm, Eq-12 [F]	L, Eq-14 [G]	Ta, Eq-16 [I]	C, Eq-13 [J]	DDm, Eq-12 [K]	L, Eq-14 [L]	[G] - [L] [M]
JAN	31	636	47	4	632	1,422	62	4	554	1,101	321
FEB	28	518	50	4	488	1,098	63	4	431	855	242
MAR	31	428	56	4	357	803	64	4	322	640	163
APR	30	147	65	4	81	182	65	4	88	176	6
MAY	31	25	73	5	0	0	67	5	0	0	0
JUN	30	0	81	5	0	0	68	5	0	0	0
JUL	31	0	82	6	0	0	68	5	0	0	0
AUG	31	0	82	6	0	0	68	5	0	0	0
SEP	30	18	77	5	0	0	67	5	0	0	0
OCT	31	124	67	4	23	52	66	4	40	80	(28)
NOV	30	417	55	4	375	844	64	4	337	669	175
DEC	31	648	48	4	601	1,353	63	4	529	1,050	304
YEAR	365	2,961			2,557	5,753			2,302	4,571	1,183
		DDa									

JOB EMC #3105.000 Ft. McPherson/Gillem ESOS

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

SHEET NO _____ OF _____

CALCULATED BY _____ CEL _____ DATE 9/2/92

CHECKED BY _____ DATE _____

SCALE _____

SAMPLE CALCULATION

Column A: JAN, the month January
 Column B: 31, Nm, number of days in month
 Column C: 636, Degree days based on 65oF (last number in this column is DDa)
 Column D: 47, Outside air temperature oF
 Column E: 4, Correction Factor, C, Equation 13, page C-14.2.5
 Column F: 659, Correct Degree Day base, DDm, Equation 12, page C-14.2.5
 Column G: 1518, Monthly energy consumption, L, Equation 14, page C-14.2.5
 Column H: .184, Radiant factor, M, Equation 17, page C-14.2.7
 Column I: 62, Indoor air temp oF, Ta, Equation 16, page C-14.2.6
 Column J: 4, Correction Factor, C, Equation 13, page C-14.2.5
 Column K: 554, Correct Degree Day base, DDm, Equation 12, page C-14.2.5
 Column L: 1101, Monthly energy consumption, L, Equation 14, page C-14.2.5
 Column M: 321, Savings, column G minus L

[A]	Nm [B]	[C]	Tosa [D]
JAN	31	636	47

C, Eq-13
[E]

$$1.339 * (0.00387 * \$DDA - 2.77E - 07 * \$DDA^2) * @EXP(-((\$TO - \$G/\$BLC - D26 + 20)/16.23)^{0.1})$$

DDm, Eq-12
[F]

$$@MAX(\$B26 * (\$TO - \$G/\$BLC - \$D26 + E26), 0)$$

L, Eq-14
[G]

$$+ \$BLC * F26 * 24 / \$CEC / 1000000$$

M, Eq-17
[H]

$$+ \$RAD / \$AF / 1.22 * (0.35 + 0.35 * 0.64 / 0.58) * \$BLC / \$CER$$

Ta, Eq-16

[I]

$$+ \$TO - (H26 / (H26 + 1)) * (\$TO - D26 - \$G/\$BLC)$$

C, Eq-13
[J]

$$1.339 * (0.00387 * \$DDA - 2.77E - 07 * \$DDA^2) * @EXP(-((I26 - \$G/\$BLC - D26 + 20)/16.23)^{0.1})$$

DDm, Eq-12
[K]

$$@MAX(\$B26 * (I26 - \$G/\$BLC - \$D26 + J26), 0)$$

L, Eq-14
[L]

$$+ \$BLC * K26 * 24 / \$CER / 1000000$$

[G] - [L]
[M]

$$+ G26 - L26$$

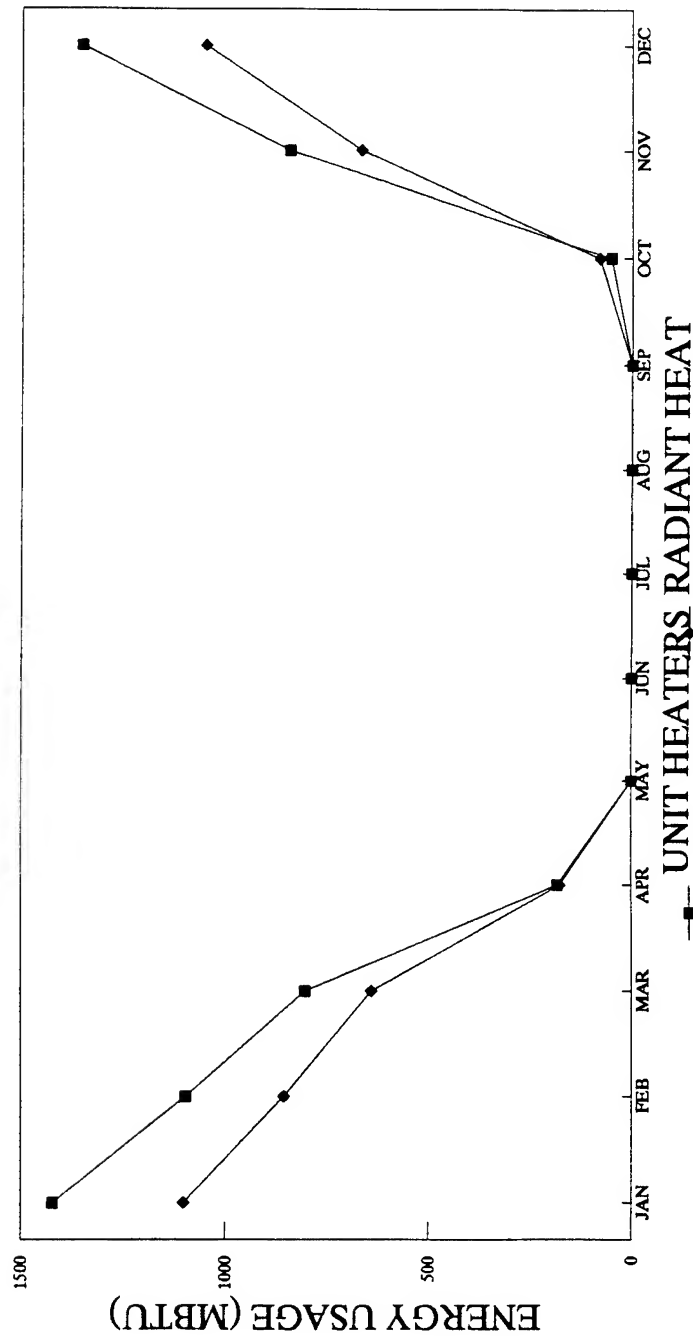
C. 14.2.3A

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/02/92
FILE: RADIANT.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:



RADIANT HEAT
HEAT LOADS

HOUR	WEEKDAY PROFILE	WEEKEND PROFILE	INTERNAL PEAK LOAD	WEEKDAY HOURLY LOAD	WEEKEND HOURLY LOAD	WEEKLY AVERAGE HOURLY INTERNAL LOADS
1	0.05	0.05	375332	18767	18767	
2	0.05	0.05	375332	18767	18767	
3	0.05	0.05	375332	18767	18767	
4	0.05	0.05	375332	18767	18767	
5	0.05	0.05	375332	18767	18767	
6	0.05	0.05	375332	18767	18767	
7	0.05	0.05	375332	18767	18767	
8	0.8	0.05	375332	300266	18767	
9	1	0.05	375332	375332	18767	
10	1	0.05	375332	375332	18767	
11	1	0.05	375332	375332	18767	
12	0.8	0.05	375332	300266	18767	
13	1	0.05	375332	375332	18767	
14	1	0.05	375332	375332	18767	
15	1	0.05	375332	375332	18767	
16	0.8	0.05	375332	300266	18767	
17	0.8	0.05	375332	300266	18767	
18	0.4	0.05	375332	150133	18767	
19	0.05	0.05	375332	18767	18767	
20	0.05	0.05	375332	18767	18767	
21	0.05	0.05	375332	18767	18767	
22	0.05	0.05	375332	18767	18767	
23	0.05	0.05	375332	18767	18767	
24	0.05	0.05	375332	18767	18767	
AVERAGE				160298	18767	119860

SEE COMPUTER SIMULATION OF BLDG 207 FOR PEAK LOAD AND LOAD PROFILE

BUILDING LOAD COEFICENT	0.471 Btu/sq.ft./hr/oF x 149300 sq.ft	70320
-------------------------	---------------------------------------	-------

SEE COMPUTER SIMULATION OF BLDG 207 FOR BLDG HEAT LOSS COEF.

Energy Consumption Calculations

The chief characteristic of radiant heating systems which results in energy savings is the reduction in room air temperatures and a corresponding reduction in envelope heat loss. Additional energy savings are also often the result of an increase in combustion efficiency over conventional heating equipment efficiencies. A simple means for determining heating loads is the variable degree day method [Ref. 8]. The Variable Base Degree Day method was selected due to its simplicity and its compatibility with the mathematical model. The Bin method was also considered, but was rejected since part-load efficiencies for radiant equipment were not available. The only advantage of the Bin method was its ability to consider part-load efficiencies.

Monthly values of degree days at a base temperature of 65°F (18°C) are tabulated for many locations all over the world [Ref. 5, 6]. The base 65°F (18°C) temperature may be corrected to other bases by the following formula [Ref. 4]:

$$DDm = Nm (t_b - t_{OSA} + C) , \quad (12)$$

where

DDm = degree days at the new base temperature,

Nm = number of days in the month,

t_b = new base temperature,

t_{OSA} = average outside air temperature,

C = correction factor.

The correction factor (C) is given by:

$$C = 1.339(0.00387 \text{ DDa} - 0.277 \times 10^{-6} \text{ DDa}^2) \\ \times \exp - [(t_b - t_{OSA} + 20^\circ\text{F}) / 16.23]^2 , \quad (13)$$

where

DDa = annual base 65°F degree days.

Monthly energy consumption (L) for space heating is:

$$L = \text{BLC} \times \text{DDm} / E_{cc} , \quad (14)$$

where

BLC = building loss coefficient,

E_{cc} = combustion efficiency of a conventional system.

The BLC is the sum of the individual heat loss factors (component area divided by thermal resistance) for building components plus infiltration/ventilation loads. The following components are generally included:

- Walls
- Ceiling
- Windows
- Doors
- Floor perimeter
- Infiltration/ventilation.

Base temperature (t_b) is calculated as follows:

$$t_b = t_a - Q_g/UA , \quad (15)$$

where Q_g is the energy generated by lights, equipment, occupants, and solar gains.

The heating load for the conventional heating system is then calculated using equation (14) in which degree days is based on the base temperature from equation (15). For conventionally heated buildings, the indoor air temperature (t_a) in equation (15) is equal to the thermostat setpoint.

Radiant Heat Evaluation

The previous study used a computer model to iteratively solve equations (7) through (11) in the order presented. In order to make the model more efficient and to develop nomographs, it was necessary to develop a single equation for performance.

For any given application, equations (7) through (11) will have five unknowns:

- ERF_c = radiant flux from ceiling,
- ERF_f = radiant flux from floor,
- t_a = indoor air temperature,
- t_f = floor temperature,
- Q_R = system energy input.

Solving the five equations simultaneously results in the following expression for indoor air temperature (t_a):

$$t_a = t_b - [M/(M+1)](t_b - t_{osa} - Q_g/BLC) , \quad (16)$$

where

- t_o = desired operative temperature,
- M = radiant factor,
- t_{OSA} = outside air temperature,
- Q_G = internal generated heat from lights, people, and equipment,
- BLC = building envelope heat loss factor.

The radiant factor (M) is given by:

$$M = \frac{E_R}{A_F(h_r + h_c)} \left(F_c + \frac{F_F h_r}{h_t} \right) \frac{BLC}{E_{CR}}$$

where

- E_R = radiant efficiency,
- A_F = floor area,
- h_t = total heat transfer coefficient from floor to room,
- F_c = ceiling angle factor,
- F_F = floor angle factor,
- h_r = radiative exchange coefficient of human body,
- E_{CR} = combustion efficiency.

Once indoor air temperature (t_o) is calculated, the remaining unknowns may be calculated from the equations (7) through (10).

The heating load for the radiantly heated building is calculated in two parts; for the floor and for the rest of the building. The floor in a radiantly heated building is maintained at a temperature higher than inside air temperature and thus has a proportionally higher heat loss. For the floor, the base temperature of equation (15) is set at the monthly floor temperature predicted for the radiant system. Heating load of the floor is then the corrected degree days based on floor temperature times the floor loss component of BLC divided by the combustion efficiency.

For the non-floor heating load, the base temperature is calculated from the indoor air temperature predicted for the radiantly heated space. The heating load of the non-floor components is then the corrected degree days times the non-floor components of the

BLC divided by the combustion efficiency. The total radiant heating load is then the sum of floor and non-floor heating loads.

For further information, the following references may be useful.

1. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "Infrared Radiant Heating," ASHRAE Handbook, 1987 Systems and Applications Volume, Chapter 16, Atlanta, Georgia.
2. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "High-Intensity Infrared Heaters," ASHRAE Handbook, 1983 Equipment Volume, Chapter 30, Atlanta, Georgia.
3. Fanger, P.O., Thermal Comfort, McGraw-Hill Book Co., New York, 1973.
4. Lunde, Peter J. "Adjusting Degree Days," Solar Age, November 1982, pp. 57.
5. U.S. Department of the Air Force, the Army, and The Navy, Engineering Weather Data, AFM 88-29/TM 5-785/NAVFAC, p. 89, 1 July 1978.
6. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Local Climatological Data, Annual Summaries for 1984, Parts I-V, May 1985.
7. Wilson, T., and R. Belske, "Movable Insulation Systems," ASHRAE Journal, pp. 26-31, February 1987.
8. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "Energy Estimating Methods," ASHRAE Handbook, 1985 Fundamentals Volume, Chapter 28, Atlanta, Georgia.
9. "Energy Prices and Discount Factors for Life-Cycle Cost Analysis," NBSIR 85-3273, -2 (Rev. 6/84).
10. "Radiation in Energy Systems," AIAA/ASME 4th Thermophysics and Heat Transfer Conference, Boston, 1986.
11. Tervin, R.R., F.M. Langdon, R.M. Nelson, M.B. Pate. "An Experimental Study of a Multipurpose Commercial Building with Three Different Heating Systems." Dept. of Mechanical Engineering, Iowa State University, May 1986.
12. "Radiant Heat Investigation." USAREUR Contract No. DACA 90-86-D-0054, February 1988.

[illegible]

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

X CODE A ☐ CODE B ☐ CODE C ☐
☐ OTHER ☐

EFFECTIVE PRICING

DATE APR 92

DRAWING NO.

DATE PREPARED

22-Apr-92

SHT OF

CHECKED BY CBL

SHIPPING

Unit Wt

Unit Wt

Unit Wt

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ESTIMATOR RMG

TOTAL

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Unit Price Cost

Unit Price Cost

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Unit Price Cost

Unit Price Cost

LABOR

Quantity

No. Of Units

Unit Meas

MH/ Unit

Total Hrs

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

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Unit Price

Cost

SUBTOTAL

OVER-HEAD, BOND

PROFIT

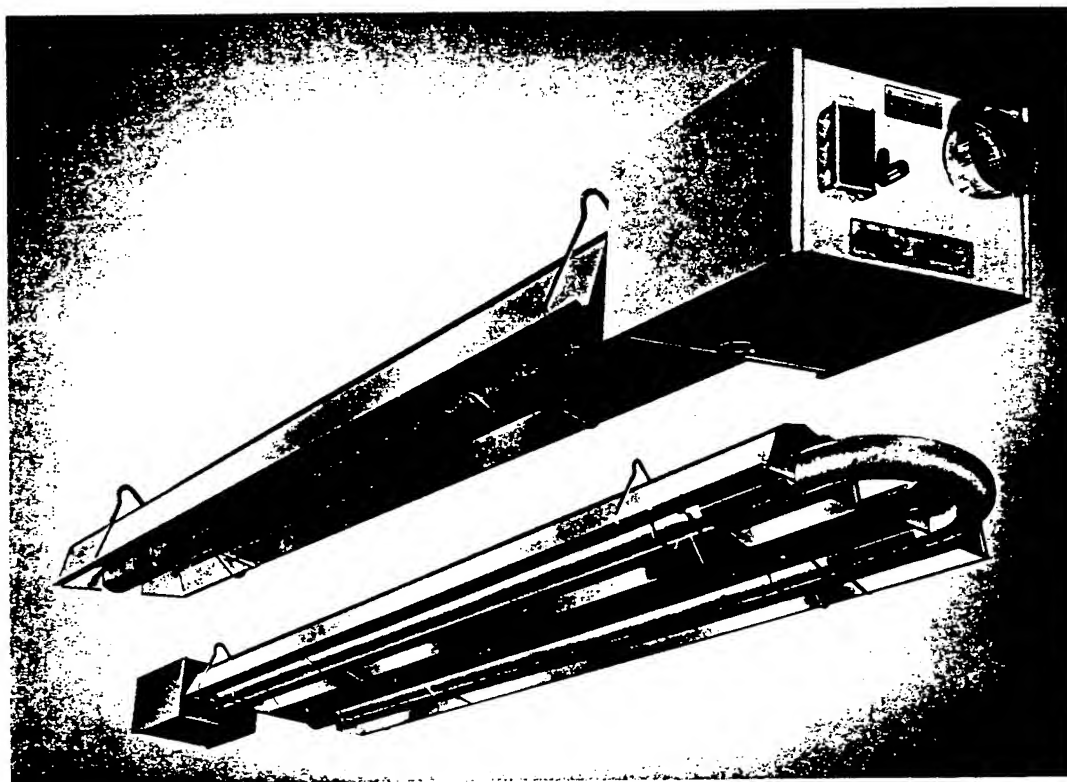
COST SUB-TOTAL

CONTINGENCY

TOTAL

VANTAGE II[®]

*Cost-Saving,
Low-Intensity Infrared
Unitary Heaters*



Roberts-Gordon, Inc.

Energy Efficient Comfort.

VANTAGE II Unitary Heaters

Lower Fuel Costs and Raise Comfort Levels.

Demonstrated Savings

Modern gas combustion technology combined with the principles of infrared energy enable VANTAGE II heaters to reduce fuel costs substantially while improving comfort conditions. Users report heating bills cut by up to 50% and more!

Low Cost...Easy to Install and Maintain

The VANTAGE II models are low-cost, field-assembled infrared heaters that are easy to install and require only minimal maintenance. They are designed to provide years of economical operation and trouble-free service.

Versatility

VANTAGE II heaters can be installed separately or in combination to fit any floor plan. Straight, L- and U-tube configurations are available. Tube lengths are offered from 10 through 60 feet. Ideal for large areas as well as hard-to-heat spaces!

Reliability and Expertise

Roberts-Gordon pioneered low-intensity infrared heating systems in 1962 and manufactures the broadest line of low-intensity heating equipment in North America. Backed by a limited three-year warranty, each VANTAGE II unitary heater is built to uphold the well-established Roberts-Gordon standards of engineering excellence, efficiency and reliability.

Applications Include:

- Automotive Facilities
- Warehouses
- Manufacturing Facilities

- Fire Stations
- Agricultural Buildings
- Recreational Facilities

- Machine Shops
- Aircraft Hangars
- Vehicle Maintenance Buildings



Clean, quiet, draft-free Vantage radiant heat is ideal for this automotive service facility. Unlike forced-air unit heaters, Vantage does not spread dirt, grit or dust.



Vantage unitary heaters are available in a variety of lengths, shapes and configurations to fit any floor plan. Two straight-tube models are shown above in a car dealership.



Floors are kept warm by Vantage infrared energy and act as heat reservoirs to provide rapid heat recovery after bay doors are closed in this warehouse/shipping area.

Features:

- Extensive use of corrosion-resistant materials.
- Weight-saving construction to ease installation.
- Forced draft design eliminates the need for a heat-siphoning draft hood.
- Quiet operation.
- 10 through 60 foot tube lengths.
- Three-year limited warranty on all components.
- A.G.A. design certified.

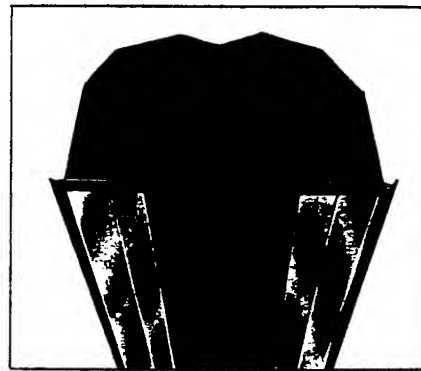
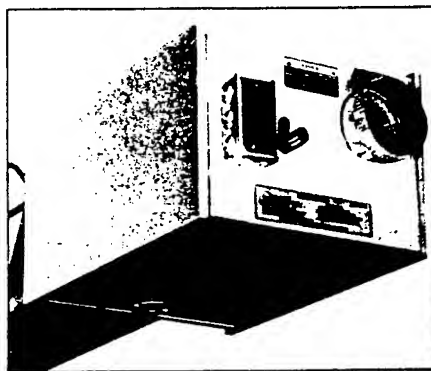
Burner Box:

- 40,000; 60,000; 80,000; 100,000; 125,000 and 150,000 BTU/Hr. models available.
- Natural gas and L.P. models available.
- Moisture-resistant design.
- Stainless steel burner cup.
- Outside air adapter standard.
- Hot surface ignition.
- Three-try ignition module.
- Door interlock safety switch.
- All components easily accessed.
- Electrostatically applied paint.
- Durable spot welded construction.
- Mica flame observation window.
- Balanced air rotor.
- Stainless steel flex gas line and high pressure gas cock included.

Tube and Reflector:

- 4" diameter 16 gauge tubing.
- Quick assembly couplings.
- Deep-dish aluminum reflectors maximize energy reflection, beaming virtually all of the radiant heat downward.
- Reflectors can be tilted 45° to direct heat where needed.
- Entire U-tube heater also can be tilted 45°.
- End caps included.
- Nickel plated hangers.
- Chrome plated hardware.
- Flue connector included.
- 180° U-package (9" radius) option.
- 90° L-package option.
- Decorative grille option.
- Side reflector option.

"The VANTAGE II heater utilizes design concepts and engineering principles proven by more than 25 years of infrared heating experience."



Architectural/Engineering Short Form Specifications VANTAGE II CTH2 SERIES

Gas-fired, vented, infrared heaters shall be furnished and installed in accordance with governing codes and as shown per building drawing(s) as described below.

Heaters shall be VANTAGE II, model number CTH2- _____, _____ BTU/Hr. as manufactured by Roberts-Gordon, Inc., Buffalo, New York.

Heaters shall be equipped with a direct sense silicon-carbide hot surface ignition control system with 100% shut-off ignition device. Power supplied to each heater shall be 120V, 60Hz, 1 ϕ . Heater to be equipped with totally enclosed motor with thermal overload motor protection, balanced air rotor, combustion air proving safety pressure switch, stainless steel burnerhead, combustion chamber equipped with sight glass for visual inspection of igniter element and burner flame. Air intake collar standard. Radiant tube assembly to be 4" diameter, aluminized steel first 10 feet. Hot rolled steel remainder of unit. (Or at customer option, all aluminized steel for entire tube length.) Reflector to be of aluminum material and designed to direct all radiant output below horizontal centerline of radiant tube. Heaters shall be vented in accordance with manufacturer's recommendations and ANSI Z-223.1 National Fuel Gas Code. Heaters shall be so designed to operate without requiring heater modifications or adjustments on _____ gas having a net heating value of _____ BTU per cubic foot and a specific gravity of _____.

Heaters shall be Design Certified by the American Gas Association (A.G.A.). Supplier shall provide a manufacturer's written warranty covering all components for a period of three (3) years.

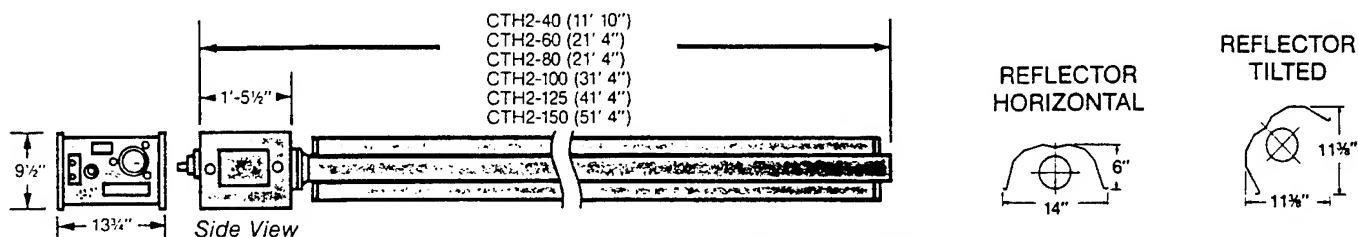
VANTAGE II®

CTH2 SERIES SPECIFICATIONS

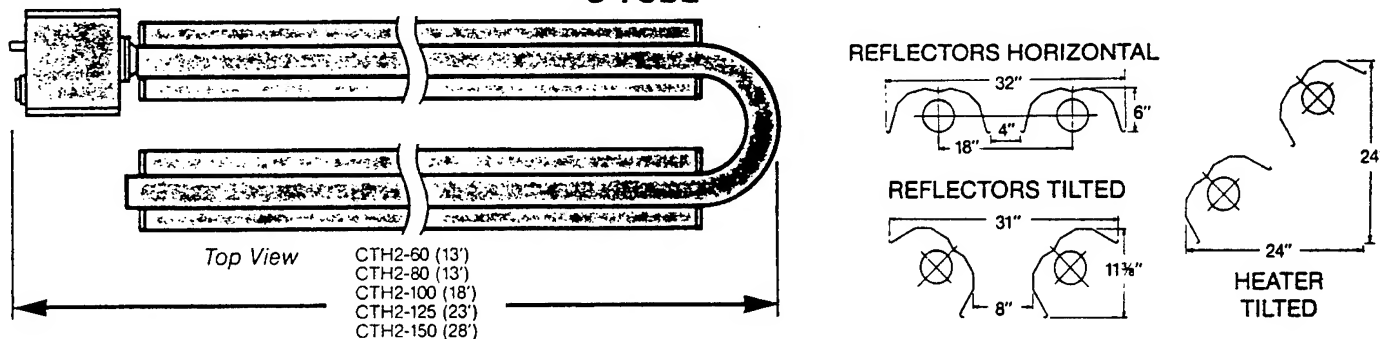
FLUE CONNECTION	GAS CONNECTION	ELECTRICAL RATING	TUBE DIAMETER	IGNITION SYSTEM	MIN. GAS INLET PRES.
4" (O.D.)	1/2" NPT	120VAC, 60Hz. 1.0 amp run 5.0 amp start	4"	Hot surface (Three-try)	Nat. 4.6" W.C. L.P. 11.0" W.C.

MODEL	BTU/Hr. (Natural Gas or L.P.)	SHIPPING WEIGHT	MODEL	BTU/Hr. (Natural Gas or L.P.)	SHIPPING WEIGHT
CTH2-40	40,000	95 lbs.	CTH2-100	100,000	165 lbs.
CTH2-60	60,000	130 lbs.	CTH2-125	125,000	200 lbs.
CTH2-80	80,000	130 lbs.	CTH2-150	150,000	235 lbs.

DIMENSIONS (Standard Models) STRAIGHT



U-TUBE



CLEARANCES TO COMBUSTIBLES*

Configuration	Reflector	CTH2-40			CTH2-60			CTH2-80			CTH2-100			CTH2-125			CTH2-150		
		Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side
Straight	Horizontal	4"	50"	22"	4"	60"	30"	4"	63"	33"	4"	68"	35"	4"	74"	41"	4"	77"	45"
Straight	Tilted	4"	45"	4"/42"	4"	54"	4"/50"	4"	60"	4"/56"	6"	68"	4"/60"	6"	72"	4"/65"	8"	78"	4"/70"
U-Tube	Horizontal	—	—	—	4"	60"	25"/30"	4"	66"	32"/33"	4"	73"	34"/35"	4"	76"	38"/41"	4"	81"	42"/45"
U-Tube	Tilted	—	—	—	4"	54"	18"/50"	4"	60"	18"/56"	6"	68"	18"/60"	6"	72"	18"/66"	8"	78"	18"/70"

Configuration	Heater	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side
U-Tube	Tilted	—	—	—	4"	54"	4"/38"	4"	60"	4"/42"	4"	68"	4"/48"	4"	72"	57"	4"	78"	4"/62"

*See installation manual for complete information.



Roberts-Gordon, Inc.

Subsidiary of A.J. Industries, Inc.

P.O. Box 44 • Buffalo, NY 14240-0044
Phone: (716) 852-4400 • Fax: (716) 852-0854



CALL TOLL FREE: 1-800-828-7450
IN NEW YORK: 1-800-221-0955

C-14.2.14

APPENDIX C-15

SEPARATE SWITCHES TO CONTROL LIGHTING

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 SEPARATE SWITCHES FOR LIG

ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	26971.
B. SIOH	\$	1484.
C. DESIGN COST	\$	1619.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	30074.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	163.	\$ 1218.	15.61	19014.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	-18.	\$ -82.	23.77	-1954.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		145.	\$ 1136.		\$ 17060.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	1141.
(1) DISCOUNT FACTOR (TABLE A)		14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	16579.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	16579.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	5630.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .75		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 2277.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 33639.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.12
 (IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.21

**SEPARATE LIGHT SWITCHES SAMPLE CALCULATION, ECO #15
BUILDING 184, ROOM 6**

Given:

# of Fixtures	= 2 fixture	- from survey notes
Fixture Type	= 4x2 4-lamp fluorescent	- from survey notes
Watts / Fixture	= 155 W / fixture	- from manufacturer info
Percent Lighting Savings	= 19%	- average for all bldgs
Hours On / Year	= 3,393 hrs / yr	- from bldg occupancy
Gas Increase Factor	= 5.4E-4 MBtu / kWh	- from computer simulation
Electric Savings Factor	= 0.17 kWh / kWh	- from computer simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Lighting Demand:

$$(2 \text{ fixtures}) * (155 \text{ W / fixture}) = 0.31 \text{ kW}$$

Peak Demand Savings:

$$(0.31 \text{ kW}) * (0.19) = 0.06 \text{ kW}$$

Annual Energy Savings:

Electric:

Lighting:

$$(0.06 \text{ kW}) * (3,393 \text{ hrs / yr}) = 200 \text{ kWh / yr}$$

Cooling:

$$(200 \text{ kWh}) * (0.17 \text{ kWh / kWh}) = 34 \text{ kWh / yr}$$

Total:

$$200 + 34 \text{ kWh / yr} = 234 \text{ kWh / yr}$$

Gas:

$$(200 \text{ kWh / yr}) * (5.4\text{E-}4 \text{ MBtu / kWh}) = 0.1 \text{ MBtu / yr}$$

Annual Cost Savings:

$$(234 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.06 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) - (0.1 \text{ MBtu}) * (\$4.67 / \text{MBtu}) = \$12.08 / \text{yr}$$

Estimated Construction Cost:

\$65.11 / wall sensor - from engineer's cost estimate

$$(\$65.11 / \text{ea}) * (1 \text{ sensor}) = \$65$$

$$\$65 + (\$65 * .055 \text{ SIOH}) + (\$65 * .055 \text{ DESIGN}) = \$72$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 15, SEPARATE SWITCHES TO CONTROL LIGHTING

EMC PROJECT:
DATE: 07/20/92
FILE: MLTISR.WK3
PREPARED BY: CAMERAN DIBAI
CHECKED BY:

#3105.000
07/20/92
MLTISR.WK3
CAMERAN DIBAI

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY COST		DISCOUNT FACTOR
INCREMENTAL GAS COST		23.77 UPWG
INCREMENTAL ELECTRIC COST		15.61 UPWE
ELECTRIC DEMAND CHARGE		14.53 UPW
ECONOMIC LIFE		25 YRS
ESTIMATED 8760 HOURS OF LIGHTING PER YEAR		

BLDG	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENERGY SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
103	0.304	1,702.0	(0.58)	5	\$41	\$31	\$0	\$72	\$436	2.4	6.1
213	2.3	9,316.4	(1.72)	30	\$230	\$236	\$0	\$466	\$3,349	2.1	7.2
935	1.23	6,193.0	(5.80)	15	\$131	\$126	\$0	\$257	\$3,465	1.1	13.5
101	7.28	30,555.0	(9.48)	95	\$735	\$747	\$0	\$1,482	\$22,822	1.0	15.4
TOTAL	11.11	47,766.4	(17.58)	145	\$1,136	\$1,141	\$0	\$2,277	\$30,072	1.1	13.2
400	0.53	1,723	(2.96)	3	\$30	\$54	\$0.00	\$85	\$2,417	0.5	28.6
207	3.17	15,020	(28.50)	23	\$250	\$325	\$0.00	\$575	\$17,634	0.4	30.6
505	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
506	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
507	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
508	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
509	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
510	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
511	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
512	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
513	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
514	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
401	0	951	(1.60)	2	\$17	\$0	\$0.00	\$17	\$2,208	0.1	131.6

[illegible]

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

☒ CODE A ☐ CODE B ☐ CODE C
☐ OTHER

EFFECTIVE PRICING

DATE APR 92

DRAWING NO.

DATE PREPARED

22-Apr-92

SHT OF

CHECKED BY CEL

SHIPPING

TOTAL

Unit

Wt

Total

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

Unit

Wt

TASK DESCRIPTION	Quantity	No. Of Units	Unit Meas	LABOR		Unit Price	Cost	EQUIPMENT		Unit Price	Cost	MATERIAL		Unit Price	Cost	TOTAL		Unit	Wt	Total	Wt
				MH/	Total Hrs			Unit Price	Cost			Unit Price	Cost								

ELECTRICAL REWIRING FOR MULTIPLE LIGHT SWITCHING (LINE VOLTAGE)																					
TASK DESCRIPTION																					

ADD LIGHT SWITCH																					
SWITCH AND COVERPLATE	1	EA		0.4	0.4	\$21.17	\$8.47					\$6.45	\$6.45			\$14.92					
OUTLET BOX AND EXT. RING	1	EA		0.55	0.55	\$21.17	\$11.64					\$4.65	\$4.65			\$16.29					

MOUNT SWITCHBOX, PATCH AND REPAIR 5.5 DRYWALL, PLASTER, PAINT	1	EA		3	3	\$21.17	\$63.51					\$20.00	\$20.00			\$83.51					
CONDUIT AND WIRE	0.2	CLF		6.15	1.23	\$21.17	\$26.04					\$47.00	\$9.40			\$35.44					

CONNECTIONS AT CEILING LIGHT	1	EA		0.5	0.5	\$21.17	\$10.59					\$3.00	\$3.00			\$13.59					
WIREMOLD SURFACE METAL RACEWAY SWITCHBOX AND SWITCH	5	LF		0.8	4	\$21.17	\$84.68					\$0.47	\$2.35			\$87.03					
	1	EA		0.7	0.7	\$21.17	\$14.82					\$10.00	\$10.00			\$24.82					

SUBTOTAL							\$219.74									\$55.85	\$275.59				
OVERHEAD, BOND	15%						\$32.96									\$8.38	\$41.34				
PROFIT	10%						\$21.97									\$5.59	\$27.56				
COST SUB-TOTAL							\$274.68									\$69.81	\$344.49				
CONTINGENCY	15%						\$41.20									\$10.47	\$51.67				
TOTAL							\$315.88									\$80.28	\$396.17				

**TheWatt
Stopper** 

Passive Infrared Wall Switch

- ♦ Simply replaces existing light switches
- ♦ Large 1000 sq. ft. of coverage
- ♦ Built-in light level sensor
- ♦ Adjustable Sensitivity & Time Delay
- ♦ Advanced transformer/latching relay design
- ♦ Compatible with Electronic Ballasts
- ♦ Proven 30% to 70% savings
- ♦ Available in 24VDC and 24V Half Wave
- ♦ Three-year warranty; UL Listed



System Information

The Watt Stopper WI sensors simply replace existing wall switches and turn lighting systems on only when offices, conference rooms, copy rooms or utility rooms are actually occupied. Lighting systems are automatically turned off after the controlled area is left unoccupied for a user-specified length of time. When the area is used again, the lights are automatically turned on. Savings of 30% to 70% are common.

Sensor Operation

Watt Stopper WI sensors use advanced passive infrared technology to detect occupancy. With a patented, four-level, multiple cell viewing lens, the WI sensors are able to detect the difference between the infrared emissions from a human body and the background space. When no changes in infrared energy are detected for a user specified length of time (adjustable from 30 seconds to 20 minutes), the lighting systems are switched off.

Advanced Light-Level Sensing

WI-Series sensors also offer integrated light level sensing. Simply put, if the room is unoccupied and lighting systems are OFF, WI-wall switch sensors will not turn all or part of the lighting systems ON if a user-specified level of natural light already exists. A user can simply override this feature by placing his hand over the sensor for a second. This feature will save even more energy in areas with abundant natural light.

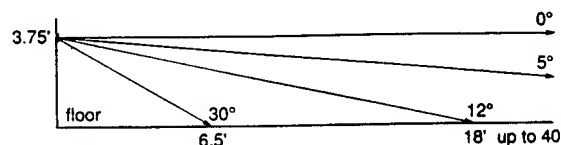
Design

WI sensors use a unique transformer and latching-relay system which allows them to work with solid state ballasts and PL lamp systems. They feature a "no-visible screws" low-profile design and an easy OFF/override. For two-gang boxes the WI sensor requires the ASP-111 for blank cover options or the ASP-112 for two level switching.

Applications and Economics

Their expansive 1000 sq. ft. of coverage, adjustable time delay, adjustable sensitivity, advanced viewing lens and built-in light level sensor make WI-series sensors highly configurable and able to handle almost any lighting situation. Due to their competitive price, low installation costs and adjustability, these sensors offer extremely fast payback rates. They are perfect for offices, utility rooms, conference rooms or any area with fluorescent or incandescent lighting systems.

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585



WI sensors use a patented viewing lens to cover 180° with a four-level pattern which eliminates mounting height problems and insures accurate detection

WI Sensor Technical Information

WI Sensor Specifications

- ♦ Part of a completely integrated line of lighting control products
- ♦ Coverage: covers a 180° area — 40 foot range with adjustment
- ♦ Auto/OFF time delay adjustable from 30 seconds to 20 minutes
- ♦ Adjustable unit sensitivity
- ♦ Integrated light level sensor — works from 5 to 400 footcandles
- ♦ Red LED display to indicate detection
- ♦ Advanced transformer/latching relay design for WI-120A & WI-277A
- ♦ Works with solid-state ballasts and PL type lamps
- ♦ No leakage current in off mode — Patent Pending
- ♦ Small size — 2.8" x 4.8" x 1" (72mm x 122mm x 26mm)
- ♦ Voltage drop protection — Patent Pending
- ♦ Integrated four level fresnel lens — Patent Pending
- ♦ Three-year warranty; UL Listed
- ♦ Available in Tamper Proof Model, and in White or Ivory

Ordering Information

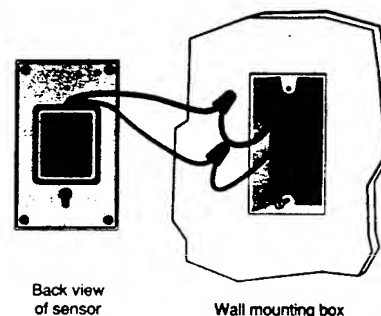
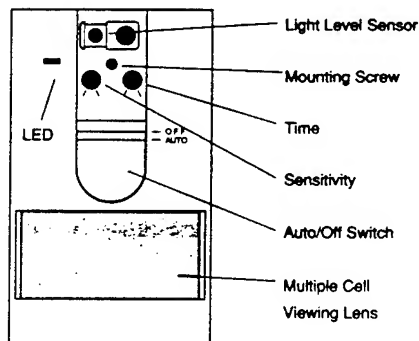
Catalog No.	Coverage	Voltage	Load Requirements	Notes
WI-120A	1000 sq. ft.	120 VAC	50-600 Watts	1
WI-277A	1000 sq. ft.	277 VAC	50-1000 Watts	1
WI-24	1000 sq. ft.	24 VDC	Two 24 VDC outputs	1,2
WI-R7P	1000 sq. ft.	24 VDC halfwave	Three RR7 Relays	1,3
ASP-111	Blank plate for Two Gang Box			1
ASP-112	Switch Plate Cover-Dual Switch			1

Notes: *1 - Add a **TP** to Catalog No. for Tamper Proof, and add a **W** for White or **I** for Ivory

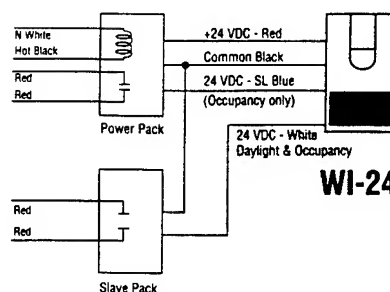
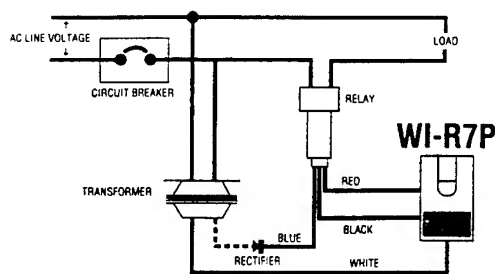
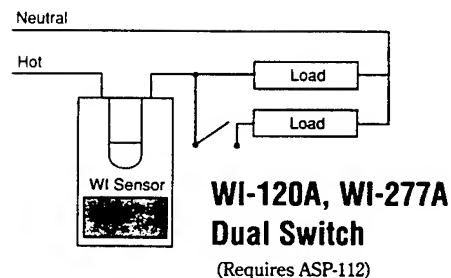
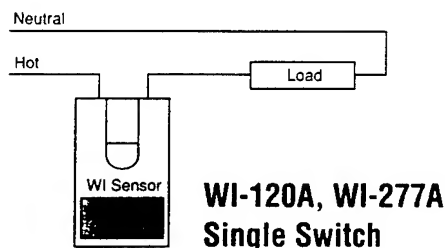
*2 - Used with Watt Stopper Power Packs

*3 - For half-wave pulse, low-voltage lighting systems

Product Controls and Installation



Circuit Schematics



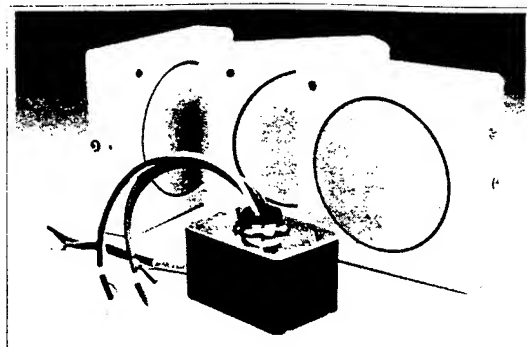
C-15.8

**TheWatt
Stopper**



Ultrasonic Sensors

- ◆ Proven 30% to 60% savings; Turn lights on only when needed
- ◆ 500, 1000 and 2000 sq. ft. coverages available
- ◆ Adjustable sensitivity & time delay
- ◆ Fully-integrated product line
- ◆ UL Listed; Three-year warranty



Complete Systems Integration

Operation

Watt Stopper Ultrasonic Sensors are part of an integrated system of lighting control products. Sensors are available to control almost any application, and can work as stand-alone products or as part of a larger lighting control system.

Watt Stopper Ultrasonic Sensors utilize advanced omni-directional ultrasonic doppler technology to sense occupancy. When ceiling mount sensors detect movement in controlled areas, they switch lighting systems on through a Watt Stopper Power Pack. The sensor controls the power pack through low-voltage wiring. As long as movement is sensed, the lights remain on. Lighting systems are switched off when no movement is detected in a user-adjustable period of time (from 15 seconds to 15 minutes).

Features

Watt Stopper Ultrasonic Sensors are designed to work across a wide variety of applications, both individually and as part of a larger system. All Watt Stopper Ultrasonic sensors feature adjustable time delay (from 15 seconds to 15 minutes), adjustable sensitivity, logic key/ON bypass and omni-directional ultrasonic technology. An LED indicator makes sensitivity adjustments easier. In addition, Watt Stopper Ultrasonic sensors are UL Listed and have a three-year warranty.

Applications

Ultrasonic sensors come in coverages of 500 sq. ft., 1000 sq. ft. and 2000 sq. ft. They're designed to work together to effectively control small offices, utility areas, open office spaces and even warehouses. The W-500A is perfect for offices, conference rooms, bathrooms and other areas up to 500 sq. ft. The W-1000A is ideal for larger spaces like classrooms and storage areas. The W-2000H is ideal for hallways, while the W-2000A is ideal for large open areas such as warehouses and can control partitioned open office spaces when configured in highly-versatile zone patterns. The W-120C and W-277C are wall switch replacement units that are ideal for small storage areas, bathrooms and enclosed rooms. All the units are designed to pick up people reaching for phones, writing, typing, etc.

Economics

Watt Stopper Ultrasonic Sensors slash utility costs by turning lights off when they're not needed. And, unlike sweep systems, they don't impair the work environment in any way. Also, easy installation and low initial cost provide fast paybacks.

- ◆ Solid State, crystal-controlled (25 KHZ±.005)
- ◆ Omni-directional transmission (360° coverage)
- ◆ Temperature and humidity-resistant 25 KHZ Microphone Receivers
- ◆ Logic Key/ON bypass
- ◆ 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) (W x L x D)
- ◆ Available in White or Ivory

C-15.9

The Watt Stopper, Inc.

Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585

Ultrasonic Sensor Technical

Ordering Information

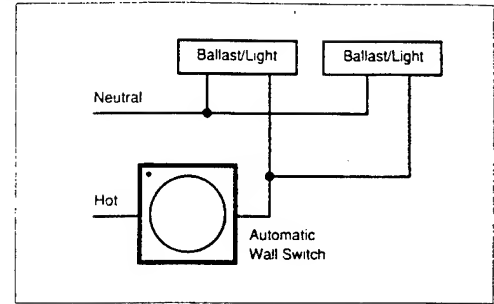
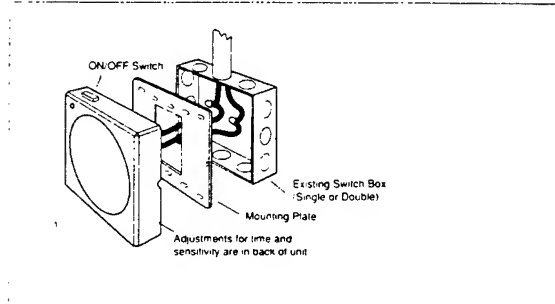
Catalog No.	Description/Type	Voltage	Current/Load	Coverage	Load Requirements
W-120C	Wall Switch	120 VAC	150-800 Watts	500 sq.ft. - 180°	
W-277C	Wall Switch	277 VAC	150-1000 Watts	500 sq.ft. - 180°	
W-500A	Ceiling Sensor	24 VDC	20 ma	500 sq.ft. - 360°	1, 2*
W-1000A	Ceiling Sensor	24 VDC	20 ma	1000 sq.ft. - 360°	1, 2*
W-2000A	Ceiling Sensor	24 VDC	20 ma	2000 sq.ft. - 360°	1, 2*
W-2000H	Hallway Sensor	24 VDC	20 mA	1000 sq.ft. **	1, 2*

*1 - Used with Watt Stopper Power Packs.

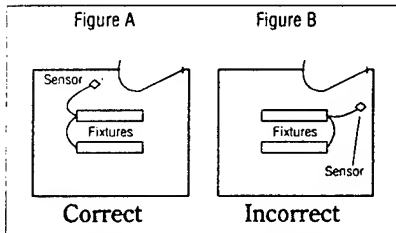
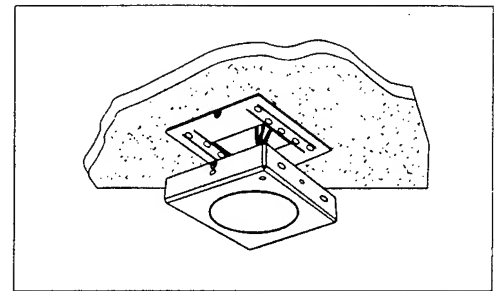
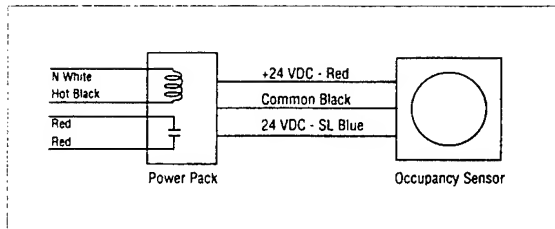
*2 - Available for Half-wave pulse, low-voltage lighting systems. Add "-24" to Catalog No.

Note: Standard models are White, add an I to Catalog No. for Ivory.

Wall Switch Placement and Schematic

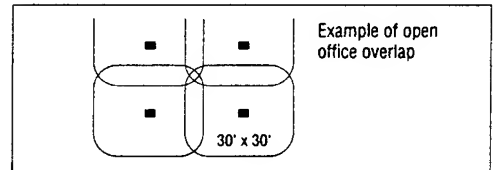


Ceiling Sensor Placement and Schematic

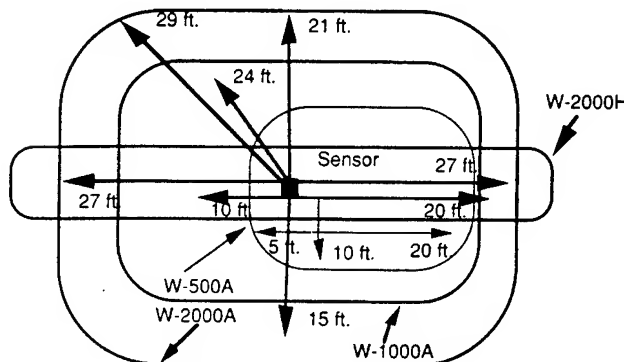


For enclosed spaces sensors should be placed as in Figure A. Sensors placed as in Figure B would see out the door, resulting in false triggering.

For standard installation use toggle bolts attaching mounting plate to ceiling tile. Always try to attach sensor to a vibration free surface.



Ceiling Sensor Coverage



For open office space the W-2000A is the most often used because of its true 360° coverage and capability to bounce off of partitions, walls, floors and other reflecting objects to sense motion. A typical layout for open office space is for the ultrasonic sensors to control the office area in zones that overlap. The coverage can be for a 20' x 20' zone and up to a maximum of 40' x 40'. A typical zone is about 25' x 25' for the lighting fixtures and an overlap on the sensor coverage that picks up to 30' x 30'.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 70

BUILDING NUMBER: 101

Sheet 1 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
218	17	4x2-4 lamp fluorescent	on	yes	no	2	no
220	12	8'-2 lamp fluorescent	on	yes	no	2	yes
222	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
223	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
225	18	4x2-4 lamp fluorescent	off	yes	no	4	no
227	10	4x2-4 lamp fluorescent	on	yes	no	1	no
228	16	4x2-4 lamp fluorescent	on	yes	no	3	no
229	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
230	2	4x2-2 lamp fluorescent	off	yes	no	1	no
232	1	4x2-4 lamp fluorescent	off	yes	no	1	no
236	4	4x2-4 lamp fluorescent	on	yes	no	1	no
336	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
339	5	4x2-4 lamp fluorescent	on	yes	no	1	no
341	2	4x2-4 lamp fluorescent	on	yes	no	1	no
343	2	4x2-4 lamp fluorescent	on	yes	no	1	no
342	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
345	3	4x2-4 lamp fluorescent	on	no	yes	0	yes
201	64	4x2-4 lamp fluorescent	on	yes	no	12	no
204	3	4x2-4 lamp fluorescent	on	yes	no	1	no
207	3	4x2-4 lamp fluorescent	on	yes	no	1	no
209	3	4x2-4 lamp fluorescent	on	yes	no	1	no
210	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
211	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
212	1	4x2-4 lamp fluorescent	on	no	no	0	yes
213	11	4x2-4 lamp fluorescent	on	yes	no	3	yes
214	14	4x2-4 lamp fluorescent	on	yes	no	3	no
215	2	4x2-4 lamp fluorescent	on	no	no	0	yes
216	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
433	2	60 Watt Incandescent	off	yes	no	1	yes
301	1	4x2-4 lamp fluorescent	off	yes	no	1	no
303	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
305	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
307	16	4x2-4 lamp fluorescent	on	yes	no	2	no
311	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
312	3	4x2-4 lamp fluorescent	on	yes	no	1	no
316	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
317	5	4x2-4 lamp fluorescent	on	yes	no	1	no
320	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
322	1	4x2-4 lamp fluorescent	off	yes	no	1	no
324	1	8'-2 lamp fluorescent	off	no	no	0	no
328	1	8'-2 lamp fluorescent	off	no	no	0	no
330	68	4x2-4 lamp fluorescent	on	yes	no	17	no
332	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
334	1	4x2-2 lamp fluorescent	on	yes	no	1	no
401	25	4x2-4 lamp fluorescent	on	yes	no	6	no
403	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
405	3	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 2 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
407	1	75 Watt Incandescent	off	yes	no	1	no
409	7	4x2-4 lamp fluorescent	on	yes	no	1	no
411	5	2x2-2 U-Bulb fluorescent	on	yes	no	2	no
413	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
414	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
416	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
419	2	60 Watt Incandescent	off	yes	no	1	no
422	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
423	2	8'-2 lamp fluorescent	off	no	yes	0	no
425	1	8'-2 lamp fluorescent	off	yes	no	1	no
427	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
429	47	4x2-4 lamp fluorescent	on	yes	no	12	no
252	6	4x2-4 lamp fluorescent	on	yes	no	3	yes
253	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
254	1	60 Watt Incandescent	off	yes	no	1	no
233	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
234	9	4x2-4 lamp fluorescent	on	yes	no	2	no
235	3	4x2-4 lamp fluorescent	on	yes	no	1	no
237	16	4x2-4 lamp fluorescent	on	yes	no	2	no
238	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
239	5	4x2-4 lamp fluorescent	on	yes	no	2	yes
240	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
241	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
242	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
243	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
244	1	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
245	1	60 Watt Incandescent	off	yes	no	1	no
246	3	4x2-4 lamp fluorescent	on	yes	no	1	no
247	3	4x2-4 lamp fluorescent	on	yes	no	1	no
248	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
249	3	4x2-4 lamp fluorescent	on	yes	no	1	no
250	8	4x2-4 lamp fluorescent	on	yes	no	2	no
251	5	4x2-4 lamp fluorescent	on	yes	no	1	no
333	9	4x2-4 lamp fluorescent	on	yes	no	3	no
335	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
337	5	4x2-4 lamp fluorescent	on	yes	no	1	no
338	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
340	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
344	2	4x2-4 lamp fluorescent	on	no	no	0	yes
200	5	4x2-4 lamp fluorescent	on	yes	no	1	no
202	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
203	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
205	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
206	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
217	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
219	63	4x2-4 lamp fluorescent	on	yes	no	8	no
221	1	60 Watt Incandescent	off	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 3 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
224	4	4x2-4 lamp fluorescent	on	yes	no	1	no
226	8	4x2-4 lamp fluorescent	on	yes	no	2	no
231	7	4x2-4 lamp fluorescent	on	yes	no	2	no
300	5	4x2-4 lamp fluorescent	on	yes	no	2	no
302	6	4x2-4 lamp fluorescent	on	yes	no	1	no
304	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
306	9	4x2-4 lamp fluorescent	on	yes	no	2	no
307	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
308	98	4x2-4 lamp fluorescent	on	yes	no	8	no
310	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
314	10	4x2-4 lamp fluorescent	on	yes	no	2	no
313	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
318	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
321	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
323	85	4x2-4 lamp fluorescent	on	yes	no	10	no
325	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
326	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
327	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
329	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
331	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
400	6	8'-2 lamp fluorescent	on	yes	no	2	no
402	10	4x2-4 lamp fluorescent	on	yes	no	2	no
406	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
404	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
408	2	8'-2 lamp fluorescent	off	yes	no	1	no
408	1	4x2-2 lamp fluorescent	off	yes	no	1	no
410	8	4x2-4 lamp fluorescent	on	yes	no	1	no
412	48	4x2-4 lamp fluorescent	on	yes	no	5	no
420	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
421	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
424	1	200 Watt Incandescent	off	no	yes	0	no
426	5	4x2-4 lamp fluorescent	on	yes	no	1	no
428	8	4x2-4 lamp fluorescent	off	yes	yes	1	no
428	3	2x2-2 U-Bulb fluorescent	off	yes	yes	1	no
430	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
431	3	4x2-2 lamp fluorescent	on	yes	no	1	no
432	3	4x2-2 lamp fluorescent	on	yes	no	1	no
39	1	150 Watt Incandescent	on	yes	yes	1	yes
25	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
24	18	4x2-4 lamp fluorescent	on	yes	no	7	no
26	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
23	8	4x2-4 lamp fluorescent	on	yes	yes	1	no
22	9	4x2-4 lamp fluorescent	on	yes	no	1	no
46	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
46A	1	150 Watt Incandescent	on	yes	yes	1	yes
75	8	4x2-4 lamp fluorescent	on	yes	no	1	no
74	8	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT GILLEM

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 4 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
74A	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
73A	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
73	10	4x2-4 lamp fluorescent	on	yes	no	1	no
72	4	4x2-4 lamp fluorescent	off	yes	no	1	no
71	12	4x2-4 lamp fluorescent	on	yes	no	1	no
HALL-1	8	4x2-4 lamp fluorescent	on	yes	no	2	no
67	2	8'-2 lamp fluorescent	off	yes	no	1	no
70	2	4x2-4 lamp fluorescent	on	yes	no	1	no
69	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
61	6	4x2-4 lamp fluorescent	on	yes	no	2	no
68	1	8'-2 lamp fluorescent	on	yes	no	1	no
59	1	150 Watt Incandescent	off	yes	no	1	no
59	2	4x2-2 lamp fluorescent	off	yes	no	1	no
60	2	4x2-4 lamp fluorescent	off	yes	no	1	no
21	20	4x2-4 lamp fluorescent	on	yes	no	2	no
58	6	4x2-4 lamp fluorescent	on	yes	no	1	no
57A	1	4x2-4 lamp fluorescent	off	yes	no	1	no
57	1	4x2-2 lamp fluorescent	off	yes	no	1	no
56	2	4x2-4 lamp fluorescent	off	yes	no	1	no
54	3	4x2-4 lamp fluorescent	on	yes	no	1	no
55	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
53	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
53A	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
53B	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
51	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
52	1	4x2-4 lamp fluorescent	on	no	yes	0	no
50	3	4x2-4 lamp fluorescent	on	no	yes	0	yes
49	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
48	12	4x2-4 lamp fluorescent	on	yes	no	2	yes
47	6	4x2-4 lamp fluorescent	off	yes	yes	1	no
45	2	8'-2 lamp fluorescent	off	yes	yes	1	no
45	2	4x2-2 lamp fluorescent	off	yes	yes	1	no
44	1	150 Watt Incandescent	on	yes	no	1	yes
43	1	150 Watt Incandescent	on	yes	no	1	yes
34	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
71	12	4x2-4 lamp fluorescent	on	yes	no	1	no
68	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
61	8	4x2-2 lamp fluorescent	on	yes	no	2	no
60	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
59	1	150 Watt Incandescent	on	yes	yes	1	no
59	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
21	20	Single lamp fluorescent	on	yes	no	1	no
21	10	Single lamp fluorescent	off	yes	no	1	no
40	2	Single lamp fluorescent	on	yes	yes	1	yes
41	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
27	12	Single lamp fluorescent	on	yes	no	1	yes
27A	2	4x2-2 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT GILLEM

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 5 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
28	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
8	8	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
2A	4	4x2-4 lamp fluorescent	on	no	yes	0	yes
2C	4	4x2-4 lamp fluorescent	on	no	yes	0	yes
2B	8	4x2-4 lamp fluorescent	on	no	yes	0	yes
5A	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
5B	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
6	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
3A	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
3B	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
19	3	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
13	52	12V-75W HALOGEN	off	yes	no	1	no
14	3	8'-2 lamp fluorescent	off	yes	no	1	no
14A	1	4x2-4 lamp fluorescent	off	yes	no	1	no
20	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
16	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
15	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
14B	2	4x2-4 lamp fluorescent	off	yes	no	1	no
65A	8	4x2-4 lamp fluorescent	off	no	yes	0	yes
65B	6	4x2-4 lamp fluorescent	on	no	no	0	yes
65C	8	4x2-4 lamp fluorescent	off	no	no	1	no
65D	12	4x2-4 lamp fluorescent	on	yes	no	1	no
76	1	4x2-4 lamp fluorescent	off	yes	no	1	no
86	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
88A	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
88	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
77	8	4x2-4 lamp fluorescent	on	yes	yes	1	yes
85	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
88	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
87	1	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
87	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
78	4	4x2-4 lamp fluorescent	off	yes	yes	2	no
79	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
80	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
81	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
82	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
84	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
83	8	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 1 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
218	2.64	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
220	2.52	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
222	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
223	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
225	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
227	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
228	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
229	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
230	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
232	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
236	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
336	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
339	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
341	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
343	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
342	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
345	0.47	3915	0.09	121	0.044	140	1	\$396.17	YES	\$65.11	NO	\$0.00
201	9.92	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
204	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
207	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
209	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
210	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
211	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
212	0.16	3915	0.00	40	0.015	47	1	\$396.17	NO	\$0.00	NO	\$0.00
213	1.71	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
214	2.17	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
215	0.31	3915	0.00	81	0.029	93	1	\$396.17	NO	\$0.00	NO	\$0.00
216	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
433	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
301	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
303	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
305	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
307	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
311	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
312	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
316	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
317	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
320	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.00
322	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
324	0.21	3915	0.00	55	0.020	63	1	\$396.17	NO	\$0.00	NO	\$0.00
328	0.21	3915	0.00	55	0.020	63	1	\$396.17	NO	\$0.00	NO	\$0.00
330	10.54	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
332	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
334	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
401	3.88	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
403	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
405	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
				2607.841						\$455.77		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 2 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
407	0.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
409	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
411	0.46	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
413	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
414	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
416	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
419	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
422	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
423	0.42	3915	0.08	109	0.039	127	1	\$396.17	YES	\$65.11	NO	\$0.00
425	0.21	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
427	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
429	7.29	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
252	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
253	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
254	0.06	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
233	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
234	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
235	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
237	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
238	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
239	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
240	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
241	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
242	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
243	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
244	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
245	0.06	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
246	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
247	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
248	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
249	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
250	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
251	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
333	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
335	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
337	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
338	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
340	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
344	0.31	3915	0.00	81	0.029	93	1	\$396.17	NO	\$0.00	NO	\$0.00
200	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
202	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
203	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
205	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
206	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$0.00	YES	\$372.00
217	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
219	9.77	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
221	0.06	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				3533.406						\$585.99		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 3 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
224	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
226	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
231	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
300	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
302	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
304	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
306	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
307	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
308	15.19	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
310	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
314	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
313	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
318	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
321	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
323	13.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
325	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
326	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
327	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
329	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
331	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
400	1.26	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
402	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
406	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
404	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
408	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
408	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
410	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
412	7.44	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
420	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
421	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
424	0.20	3915	0.04	52	0.019	60	1	\$0.00	YES	\$65.11	NO	\$0.00
426	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
428	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$0.00
428	0.28	3915	0.05	205	0.074	238	0	\$0.00	YES	\$65.11	NO	\$0.00
430	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
431	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
432	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
25	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
24	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
26	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
23	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$0.00
22	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
46A	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				7991.855						\$976.65		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 4 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
74A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
73A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
73	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
72	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-1	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
69	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
61	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.21	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	3.10	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
57A	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
57	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
56	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
54	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
55	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
53	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
53A	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
53B	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
51	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
52	0.16	3915	0.03	40	0.015	47	1	\$396.17	YES	\$65.11	NO	\$0.00
50	0.47	3915	0.09	121	0.044	140	1	\$396.17	YES	\$65.11	NO	\$0.00
49	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
48	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
47	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$372.00
45	0.42	3915	0.08	312	0.112	362	0	\$0.00	YES	\$65.11	NO	\$0.00
45	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
44	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
43	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
34	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
71	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.21	3915	0.04	156	0.056	181	0	\$0.00	YES	\$65.11	NO	\$0.00
61	0.71	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
59	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
59	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
21	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
40	0.08	3915	0.02	60	0.021	69	0	\$0.00	YES	\$65.11	NO	\$0.00
41	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
27	0.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
7A	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				4755.218						\$976.65		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 5 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
28	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.74	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2A	0.62	3915	0.12	161	0.058	187	1	\$396.17	NO	\$0.00	YES	\$372.00
2C	0.62	3915	0.12	161	0.058	187	1	\$396.17	NO	\$0.00	YES	\$372.00
2B	1.24	3915	0.24	322	0.116	374	2	\$792.34	NO	\$0.00	YES	\$372.00
5A	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
5B	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
3A	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$0.00	YES	\$372.00
3B	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
19	0.28	3915	0.05	205	0.074	238	0	\$0.00	YES	\$65.11	NO	\$0.00
13	3.90	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.63	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14A	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
20	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.00
15	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
14B	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65A	1.24	3915	0.24	322	0.116	374	2	\$792.34	NO	\$0.00	YES	\$372.00
65B	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65C	1.24	3915	0.00	322	0.116	374	2	\$792.34	NO	\$0.00	NO	\$0.00
65D	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
76	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
86	0.27	3915	0.05	199	0.071	230	0	\$0.00	YES	\$65.11	NO	\$0.00
88A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
88	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$372.00
85	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.00
88	0.21	3915	0.04	156	0.056	181	0	\$0.00	YES	\$65.11	NO	\$0.00
87	0.09	3915	0.02	68	0.025	79	0	\$0.00	YES	\$65.11	NO	\$0.00
87	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
78	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
79	0.31	3915	0.06	81	0.029	93	1	\$396.17	YES	\$65.11	NO	\$0.00
80	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$0.00	YES	\$372.00
81	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
82	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
84	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
83	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	211.910		7.2751	26340.24	9.48	30555	19	\$7,131.06		\$4,036.82		\$9,300.00
Total \$ Expense = \$20,467.88												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 103LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 9

BUILDING NUMBER: 103

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 600 to 1900
Schedule #2 M-F 0 to 2400 S-S 0 to 2400

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
2	4	4x2-2 lamp fluorescent	off	yes	no	2	no
3	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
4	1	4x2-2 lamp fluorescent	off	yes	no	1	no
5A	1	150 Watt Incandescent	off	yes	yes	1	no
5B	1	150 Watt Incandescent	off	yes	no	1	no
6	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
7	1	150 Watt Incandescent	on	yes	no	1	yes
8	5	8'-2 lamp fluorescent	on	yes	no	4	yes
9	5	4x2-2 lamp fluorescent	off	yes	no	2	no
10	1	120 Watt Incandescent	on	yes	no	1	no
10	1	4x2-2 lamp fluorescent	on	yes	no	1	no
12	2	4x2-2 lamp fluorescent	off	yes	no	1	no
13	1	4x2-2 lamp fluorescent	off	yes	no	1	yes
14	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
15	20	4x2-2 lamp fluorescent	on	yes	no	3	no
15	4	8'-2 lamp fluorescent	on	yes	no	2	yes
16	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
17	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
18	1	75 Watt Incandescent	on	yes	no	1	yes
19	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
20	4	4x2-2 lamp fluorescent	on	yes	no	1	no
21	1	75 Watt Incandescent	off	yes	no	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 103LITE.WK3

CLIENT CONTRACT NO: DACA21-91-C-0097

PREPARED BY: JW

CLIENT PROJECT ENG: TERRY SEABROOK

CHECKED BY: CEL

BUILDING NUMBER: 103

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 4.00E-04 MBtu/kWh
Cooling Factor (Energy) 1.18

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.16	4745	0.03	140	0.056	165	0	\$0.00	YES	\$65.11	NO	\$0.00
2	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	0.18	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5A	0.15	4745	0.03	135	0.054	160	0	\$0.00	YES	\$65.11	NO	\$0.00
5B	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00
7	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	1.05	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.45	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.12	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.18	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.21	4745	0.04	189	0.076	223	0	\$0.00	YES	\$65.11	NO	\$0.00
15	1.78	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.84	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.47	4745	0.09	419	0.168	495	0	\$0.00	YES	\$65.11	NO	\$0.00
18	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	7.709		0.304	1442.48	0.58	1702.126	0	\$0.00		\$390.66		\$0.00
Total \$ Expense =							\$390.66					

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 207LITE.WK3

PREPARED BY: JW

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY: CEL

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 48

BUILDING NUMBER: 207

Sheet 1 of 2

Schedule #1 M-F 600 to 1800 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
BAY-4	45	8'-2 lamp fluorescent	on	yes	no	1	yes
BAY-5	45	8'-2 lamp fluorescent	on	yes	no	1	yes
130	15	75 Watt Incandescent	off	yes	no	1	no
131	15	75 Watt Incandescent	off	yes	no	1	no
54	6	4x2-4 lamp fluorescent	on	yes	no	1	yes
55	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
56	88	4x2-2 lamp fluorescent	on	yes	no	8	no
57	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
58	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
59	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
60	90	4x2-2 lamp fluorescent	on	yes	no	8	no
61	3	4x2-2 lamp fluorescent	off	yes	yes	1	no
62	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
63	3	4x2-2 lamp fluorescent	on	yes	no	1	no
64	1	75 Watt Incandescent	on	yes	no	1	no
64	2	4x2-2 lamp fluorescent	on	yes	no	1	no
65	2	8'-2 lamp fluorescent	off	yes	no	1	no
66	1	8'-2 lamp fluorescent	on	yes	no	1	yes
67	1	75 Watt Incandescent	on	yes	yes	1	yes
36	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
37	1	4x2-4 lamp fluorescent	off	yes	no	1	no
38	35	8'-2 lamp fluorescent	on	no	no	0	yes
39	6	4x2-4 lamp fluorescent	on	yes	no	1	no
40	6	4x2-4 lamp fluorescent	on	yes	no	1	no
41	66	8'-2 lamp fluorescent	on	yes	no	8	yes
42	40	8'-2 lamp fluorescent	on	yes	no	6	yes
43	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
44	6	4x2-4 lamp fluorescent	off	yes	yes	1	no
45	21	4x2-2 lamp fluorescent	on	yes	no	1	no
46	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
47	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
48	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
49	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
50	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
51	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
52	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
53	6	4x2-4 lamp fluorescent	on	yes	no	1	yes
18	1	4x2-4 lamp fluorescent	off	yes	no	1	no
19	2	4x2-4 lamp fluorescent	on	yes	no	1	no
20	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
21	6	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
22	6	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
23	6	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
24	6	4x2-4 lamp fluorescent	on	yes	no	1	no
25	8	4x2-4 lamp fluorescent	on	yes	yes	2	yes
26	3	4x2-4 lamp fluorescent	on	yes	no	1	no
27	6	4x2-4 lamp fluorescent	on	yes	no	2	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: 207LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

BUILDING NUMBER: 207

Sheet 2 of 2

Schedule #1 M-F 600 to 1800 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
27	2	2x2-2 U-Bulb fluorescent	on	no	no	0	no
28	6	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
29	14	4x2-4 lamp fluorescent	on	yes	no	3	no
30	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
30	1	2x2-2 U-Bulb fluorescent	on	no	yes	0	no
31	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
31	2	2x2-2 U-Bulb fluorescent	off	no	yes	0	no
32	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
32	2	2x2-2 U-Bulb fluorescent	on	no	no	0	yes
33	6	4x2-4 lamp fluorescent	on	yes	no	1	no
34	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
35	2	4x2-2 lamp fluorescent	off	yes	yes	1	no
1	10	4x2-4 lamp fluorescent	on	yes	no	2	no
2	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
3	1	8'-2 lamp fluorescent	off	yes	yes	1	no
4	1	8'-2 lamp fluorescent	off	yes	yes	1	no
5	15	8'-2 lamp fluorescent	on	yes	no	1	no
6	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
7	43	8'-2 lamp fluorescent	on	yes	no	1	yes
8	2	8'-2 lamp fluorescent	on	yes	no	1	no
9	3	4x2-4 lamp fluorescent	on	yes	no	1	no
10	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
11	4	4x2-2 lamp fluorescent	off	yes	yes	1	no
12	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
13	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
14a	2	4x2-4 lamp fluorescent	on	yes	no	1	no
14b	4	4x2-4 lamp fluorescent	on	yes	no	1	no
15	6	4x2-4 lamp fluorescent	on	yes	no	1	no
16	7	4x2-4 lamp fluorescent	on	yes	no	1	no
17	4	2x2-2 U-Bulb fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 207LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 207

Sheet 1 of 2

% Unnoc. lights: 19%
Gas Increase Factor 1.90E-03 MBtu/kWh
Cooling Factor (Energy) 0

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
BAY-4	9.45	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
BAY-5	9.45	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
130	1.13	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
131	1.13	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
54	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
55	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
56	7.83	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
57	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
58	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
59	0.47	3132	0.09	277	0.526	0	0	\$0.00	YES	\$65.11	NO	\$0.00
60	8.01	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
61	0.27	3132	0.05	159	0.302	0	0	\$0.00	YES	\$65.11	NO	\$0.00
62	0.47	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
63	0.27	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
64	0.08	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
64	0.18	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	0.42	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.21	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	0.08	3132	0.01	45	0.085	0	0	\$0.00	YES	\$65.11	NO	\$0.00
36	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
37	0.16	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
38	7.35	3132	0.00	1911	3.631	0	6	\$2,377.02	NO	\$0.00	NO	\$0.00
39	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
40	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
41	13.86	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	8.40	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
43	0.09	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
44	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
45	1.87	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
47	0.47	3132	0.09	277	0.526	0	0	\$0.00	YES	\$65.11	NO	\$0.00
48	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
49	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
50	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
51	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
52	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
53	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	0.16	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.31	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
20	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
21	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
22	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
23	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
24	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
25	1.24	3132	0.24	738	1.402	0	0	\$0.00	NO	\$0.00	YES	\$372.00
26	0.47	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				8449.739						\$585.99		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 207LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 207

Sheet 2 of 2

% Unnoc. lights: 19%
Gas Increase Factor 0.0019 MBtu/kWh
Cooling Factor (Energy) 0%

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
27	0.18	3132	0.00	48	0.091	0	1	\$396.17	NO	\$0.00	NO	\$0.00
28	0.55	3132	0.10	328	0.624	0	0	\$0.00	NO	\$0.00	YES	\$372.00
29	2.17	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
30	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
30	0.09	3132	0.02	24	0.045	0	1	\$396.17	YES	\$65.11	NO	\$0.00
31	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
31	0.18	3132	0.03	48	0.091	0	1	\$396.17	YES	\$65.11	NO	\$0.00
32	0.31	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
32	0.18	3132	0.00	48	0.091	0	1	\$396.17	NO	\$0.00	NO	\$0.00
33	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
34	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
35	0.18	3132	0.03	106	0.201	0	0	\$0.00	YES	\$65.11	NO	\$0.00
1	1.55	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	0.31	3132	0.06	184	0.351	0	0	\$0.00	YES	\$65.11	NO	\$0.00
3	0.21	3132	0.04	125	0.237	0	0	\$0.00	YES	\$65.11	NO	\$0.00
4	0.21	3132	0.04	125	0.237	0	0	\$0.00	YES	\$65.11	NO	\$0.00
5	3.15	3132	0.00	819	1.556	0	3	\$1,188.51	NO	\$0.00	NO	\$0.00
6	0.62	3132	0.12	369	0.701	0	0	\$0.00	NO	\$0.00	YES	\$372.00
7	9.03	3132	0.00	2348	4.461	0	8	\$3,169.36	NO	\$0.00	NO	\$0.00
8	0.42	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.47	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.09	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.36	3132	0.07	212	0.403	0	0	\$0.00	NO	\$0.00	YES	\$372.00
12	0.78	3132	0.15	461	0.876	0	0	\$0.00	NO	\$0.00	YES	\$372.00
13	0.93	3132	0.18	553	1.052	0	0	\$0.00	NO	\$0.00	YES	\$372.00
14a	0.31	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14b	0.62	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.93	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	1.08	3132	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.37	3132	0.07	219	0.416	0	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	114.97		3.17357	15020.62	28.53918	0	21	\$8,319.57		\$1,171.98		\$6,324.00
Total \$ Expense = \$15,815.55												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECC15-LIGHTING CONTROL

FILE: 170LITE.WK3

CLIENT CONTRACT NO: DACA21-91-C-0097

PREPARED BY: JW

CLIENT PROJECT ENG: TERRY SEABROOK

CHECKED BY: CEL

BUILDING NUMBER: 170

Sheet 1 of 2

% Unnoc. lights: 19%

Gas Increase Factor 1.68E-04 MBtu/kWh

Cooling Factor (Ene 1.145

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	0.15	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
28	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.93	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	1.34	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
29	0.53	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
21	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
25	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	5475	0.00	46	0.008	53	1	\$396.17	NO	\$0.00	NO	\$0.00
22	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.62	5475	0.00	162	0.027	185	2	\$792.34	NO	\$0.00	NO	\$0.00
14	0.45	5475	0.00	116	0.019	132	1	\$396.17	NO	\$0.00	NO	\$0.00
3	0.53	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
30	1.08	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
31	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
34	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
37	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
38	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
41	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
40	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
55	0.93	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
54	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.36	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
53	1.08	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.27	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
61	0.18	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
69	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.47	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
64	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
81	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
80	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
72	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
73	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
				900.2585						\$260.44		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECC15-LIGHTING CONTROL

FILE: 170LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 170

Sheet 2 of 2

% Unnoc. lights: 19%

Gas Increase Factor 1.30E-03 MBtu/kWh

Cooling Factor (Ene) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
74	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
52	0.31	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
43	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
44	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
45	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
47	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.31	5475	0.06	322	0.054	369	0	\$0.00	YES	\$65.11	NO	\$0.00
103	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
104	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
106	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
108	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
109	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
110	0.27	5475	0.05	278	0.047	318	0	\$0.00	YES	\$65.11	NO	\$0.00
111	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
112	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
116	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
118	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
119	0.15	5475	0.03	156	0.026	179	0	\$0.00	YES	\$65.11	NO	\$0.00
120	0.93	5475	0.18	967	0.163	1108	0	\$0.00	NO	\$0.00	YES	\$372.00
122	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
119A	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
HALL-	0.62	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.09	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.18	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-	0.27	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
121-1	2.79	5475	0.53	2902	0.488	3323	0	\$0.00	NO	\$0.00	YES	\$372.00
140-1	0.78	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
154	0.09	5475	0.02	93	0.016	106	0	\$0.00	YES	\$65.11	NO	\$0.00
145	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
146	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
147	0.18	5475	0.03	185	0.031	212	0	\$0.00	YES	\$65.11	NO	\$0.00
148	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
150	0.16	5475	0.03	161	0.027	185	0	\$0.00	YES	\$65.11	NO	\$0.00
149	0.16	5475	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
153	0.31	5475	0.06	322	0.054	369	0	\$0.00	YES	\$65.11	NO	\$0.00
Total	28.931		1.44761	8249.625	1.38594	9445.82	4	\$1,584.68		\$1,582.64		\$744.00
Total \$ Expense = \$3,891.32												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY: JW

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY: CEL

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 40

BUILDING NUMBER: 213

Sheet 1 of 3

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
7	8	4x2-2 lamp fluorescent	on	yes	no	1	no
24	4	4x2-4 lamp fluorescent	on	yes	no	1	no
24	8	4x2-2 lamp fluorescent	on	yes	no	1	no
8	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
12	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
11	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
10	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
Reception	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
7	12	4x2-4 lamp fluorescent	on	yes	no	2	no
8	2	4x2-4 lamp fluorescent	on	yes	no	1	no
9	3	4x2-4 lamp fluorescent	on	yes	no	1	no
13	5	4x2-4 lamp fluorescent	on	yes	no	1	yes
11	6	4x2-2 lamp fluorescent	on	yes	no	1	no
12	6	4x2-2 lamp fluorescent	on	yes	no	1	no
17	6	4x2-4 lamp fluorescent	on	yes	no	1	no
21	3	4x2-4 lamp fluorescent	on	yes	no	1	no
23	2	4x2-2 lamp fluorescent	off	yes	no	1	no
19	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
20	3	4x2-4 lamp fluorescent	on	yes	no	1	no
22	2	4x2-2 lamp fluorescent	off	yes	no	1	no
67	11	4x2-4 lamp fluorescent	on	yes	no	2	no
70	2	4x2-2 lamp fluorescent	on	yes	no	1	no
77	4	4x2-2 lamp fluorescent	on	yes	no	1	yes
77	9	4x2-2 lamp fluorescent	on	yes	no	1	yes
71	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
72	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
73	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
75	8	4x2-4 lamp fluorescent	on	yes	no	1	yes
74	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
76	19	4x2-2 lamp fluorescent	on	yes	no	1	yes
Photolab	14	4x2-2 lamp fluorescent	on	yes	no	2	no
93	4	4x2-4 lamp fluorescent	off	yes	no	1	no
96	1	4x2-4 lamp fluorescent	off	yes	no	1	no
97	1	4x2-4 lamp fluorescent	off	yes	no	1	no
Microlab	1	4x2-4 lamp fluorescent	off	yes	no	1	no
98	2	4x2-4 lamp fluorescent	off	yes	no	1	no
100	16	4x2-4 lamp fluorescent	on	yes	no	4	no
35	1	4x2-2 lamp fluorescent	off	yes	no	1	no
Chem.Rm	1	4x2-4 lamp fluorescent	on	yes	no	1	no
91	2	4x2-4 lamp fluorescent	on	yes	no	1	no
79	2	4x2-4 lamp fluorescent	on	yes	no	1	no
78	3	4x2-4 lamp fluorescent	on	yes	no	2	no
108	4	4x2-4 lamp fluorescent	on	yes	no	2	no
107	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
109	2	4x2-4 lamp fluorescent	off	yes	no	1	no
110	3	4x2-4 lamp fluorescent	on	yes	no	1	no
106	2	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: 213LITE.wk3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 213

Sheet 2 of 3

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
104	2	4x2-4 lamp fluorescent	on	yes	no	1	no
102	2	4x2-4 lamp fluorescent	on	yes	no	1	no
101	1	4x2-2 lamp fluorescent	on	yes	no	1	no
105	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
64	20	4x2-4 lamp fluorescent	on	yes	no	1	no
59	5	4x2-4 lamp fluorescent	off	yes	no	1	no
Footwear	3	4x2-4 lamp fluorescent	off	yes	no	1	no
Laser Rm	3	4x2-4 lamp fluorescent	off	yes	no	1	no
Auto Rm	6	200 Watt Incandescent	off	yes	no	1	no
111	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
111	3	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
113	4	2x2-2 U-Bulb fluorescent	off	yes	yes	1	no
114	4	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
116	4	2x2-2 U-Bulb fluorescent	on	yes	no	1	no
117	20	4x2-4 lamp fluorescent	on	yes	no	2	yes
117	8	2x2-2 U-Bulb fluorescent	on	yes	no	2	yes
119	3	8'-2 lamp fluorescent	on	yes	no	1	no
121	9	4x2-4 lamp fluorescent	on	yes	no	1	no
122	6	2x2-2 U-Bulb fluorescent	on	yes	no	1	no
123	21	8'-2 lamp fluorescent	on	yes	no	5	no
125	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
125	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	yes
127	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
127	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	yes
128	3	8'-2 lamp fluorescent	off	yes	no	1	no
129	5	8'-2 lamp fluorescent	on	yes	no	6	yes
129	12	4x2-2 lamp fluorescent	on	yes	no	6	yes
103	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
104	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
102	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
105	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
108	12	4x2-4 lamp fluorescent	on	yes	no	2	no
109	6	4x2-4 lamp fluorescent	off	yes	no	2	no
110	10	4x2-2 lamp fluorescent	off	yes	no	1	no
112	10	4x2-4 lamp fluorescent	on	yes	no	2	no
115	14	4x2-4 lamp fluorescent	on	yes	no	2	no
115	2	2x2-2 U-Bulb fluorescent	on	yes	no	2	no
118	4	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
120	9	4x2-4 lamp fluorescent	on	yes	no	2	no
124	14	4x2-4 lamp fluorescent	on	yes	no	1	no
126	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
129	32	4x2-4 lamp fluorescent	on	yes	no	1	no
58	4	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
56	4	4x2-4 lamp fluorescent	on	yes	no	1	no
55	2	4x2-4 lamp fluorescent	on	yes	no	1	no
Clean-up	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
62	4	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: 213LITE.wk3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 213

Sheet 3 of 3

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
52	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
51	16	4x2-4 lamp fluorescent	on	yes	no	3	no
65	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
66	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
45	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
48	48	4x2-4 lamp fluorescent	on	yes	no	2	no
48	22	4x2-2 lamp fluorescent	on	yes	no	2	no
42	28	4x2-4 lamp fluorescent	on	yes	no	1	no
42	6	4x2-2 lamp fluorescent	on	yes	no	1	no
79	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
27	13	4x2-4 lamp fluorescent	on	yes	no	2	no
30	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
86	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
34	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
37	6	4x2-4 lamp fluorescent	off	yes	no	1	no
38	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
39	2	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
94	235	4x2-2 lamp fluorescent	on	yes	no	1	no
95	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
96	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
97	5	4x2-4 lamp fluorescent	on	yes	no	2	yes
98	7	4x2-2 lamp fluorescent	off	yes	no	1	no
99	12	4x2-4 lamp fluorescent	on	yes	no	5	no
99	1	2x2-2 U-Bulb fluorescent	off	yes	no	2	no
100	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
101	1	4x2-2 lamp fluorescent	off	yes	no	1	no
102	4	4x2-4 lamp fluorescent	on	yes	no	2	yes
106	10	4x2-4 lamp fluorescent	on	yes	no	2	no
107	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
66	2	4x2-4 lamp fluorescent	off	yes	no	1	no
46	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
47	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
71	2	4x2-4 lamp fluorescent	on	yes	no	1	no
72	2	4x2-4 lamp fluorescent	off	yes	no	1	no
73	1	4x2-4 lamp fluorescent	off	yes	no	1	no
41	14	4x2-4 lamp fluorescent	on	yes	no	2	no
39	23	4x2-4 lamp fluorescent	on	yes	no	2	no
77	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
32	6	4x2-4 lamp fluorescent	on	yes	yes	2	yes
26	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
25	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
28	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
29	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
33	3	4x2-4 lamp fluorescent	on	yes	no	1	no
35	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
90	5	4x2-4 lamp fluorescent	on	yes	no	1	no
36	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 213

Sheet 1 of 3

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
7	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
12	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
11	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
10	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
Reception	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
7	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.09	3393	0.02	57	0.013	68	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
22	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	1.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.36	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
72	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
73	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
76	1.69	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Photolab	1.25	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
93	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
97	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Microlab	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Chem. Rm	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
91	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
78	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
108	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
107	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
109	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				1745.122						\$716.21		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 213

Sheet 2 of 3

% Unnoc. lights: 19%

Gas Increase Factor 2.20E-04 MBtu/kWh

Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
104	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
101	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
105	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
64	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Footwear	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Laser Rm	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Auto Rm	1.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.28	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
113	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
114	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
116	0.37	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	0.74	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
119	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
121	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
122	0.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
123	4.41	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
127	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
127	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
128	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
129	1.05	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
129	1.07	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
103	0.47	3393	0.09	300	0.066	357	0	\$0.00	YES	\$65.11	NO	\$0.00
104	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
102	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
105	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
108	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
109	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.89	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
112	1.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
115	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
115	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
118	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
120	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
124	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
126	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
129	4.96	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.37	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
56	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
55	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Clean-u	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
62	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				1611.03						\$260.44		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 213

Sheet 3 of 3

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
52	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
51	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	2.48	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
66	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
45	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
48	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
48	7.44	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	1.96	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	4.34	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	0.62	3393	0.12	400	0.088	476	0	\$0.00	NO	\$0.00	YES	\$0.00
30	2.02	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
86	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
34	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
37	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
38	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00
94	0.18	3393	0.03	119	0.026	141	0	\$0.00	NO	\$0.00	NO	\$0.00
95	20.92	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.62	3393	0.12	400	0.088	476	0	\$0.00	YES	\$65.11	YES	\$0.00
97	0.09	3393	0.02	57	0.013	68	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
99	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
99	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
101	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
107	1.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
47	0.47	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
71	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
72	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
73	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
41	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	3.57	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
32	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
26	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00
25	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
28	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
29	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
33	0.47	3393	0.09	300	0.066	357	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.47	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
90	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
36	0.78	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
Total	133.2		2.30736	7828.872	1.72235	9316.358	1	\$0.00		\$1,858.19		\$1,116.00
Total \$ Expense = \$3,004.19												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000
DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: G400LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 48

BUILDING NUMBER: 400

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	51	4x2-2 lamp fluorescent	on	yes	no	6	no
2	6	4x2-2 lamp fluorescent	on	no	yes	1	yes
3	6	4x2-2 lamp fluorescent	on	no	yes	1	yes
4	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
5	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
6	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
7	2	4x2-2 lamp fluorescent	off	yes	no	1	no
8	2	4x2-2 lamp fluorescent	on	yes	no	2	yes
9	24	4x2-2 lamp fluorescent	on	yes	no	3	no
10	15	8'-2 lamp fluorescent	on	yes	no	2	no
11	2	8'-2 lamp fluorescent	on	yes	yes	1	yes
12	4	8'-2 lamp fluorescent	on	yes	no	1	yes
14	36	120 Watt Incandescent	on	yes	no	5	no
15	16	4x2-2 lamp fluorescent	on	yes	no	3	yes
16	11	4x2-2 lamp fluorescent	on	yes	no	3	yes
17	25	150 Watt Incandescent	on	yes	no	2	no
18	6	4x2-2 lamp fluorescent	on	yes	no	1	no
12	7	200 Watt Incandescent	on	yes	no	1	yes
13	1	200 Watt Incandescent	on	yes	no	1	yes
13	2	200 Watt Incandescent	off	yes	no	1	no
13	2	200 Watt Incandescent	off	yes	no	1	no
19	6	8'-2 lamp fluorescent	on	yes	no	1	no
17	18	8'-2 lamp fluorescent	on	yes	no	2	no
17	4	8'-2 lamp fluorescent	on	yes	no	2	no
20	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
20	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
21	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
22	2	4x2-2 lamp fluorescent	off	yes	no	1	no
23	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
24	4	4x2-2 lamp fluorescent	off	yes	yes	1	no
25	1	8'-2 lamp fluorescent	off	yes	no	1	no
25	1	4x2-2 lamp fluorescent	off	yes	no	1	no
26	20	4x2-2 lamp fluorescent	on	yes	no	3	yes
27	64	4x2-2 lamp fluorescent	on	yes	no	8	no
28	15	4x2-2 lamp fluorescent	off	yes	no	2	no
29	65	4x2-2 lamp fluorescent	off	yes	no	9	no
29	51	200 Watt Incandescent	off	yes	no	9	no
30	34	4x2-4 lamp fluorescent	on	yes	no	2	yes
12	2	200 Watt Incandescent	off	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G400LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 400

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	4.54	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	0.53	3393	0.10	139	0.292	169	1	\$396.17	NO	\$0.00	YES	\$372.00
3	0.53	3393	0.10	139	0.292	169	1	\$396.17	NO	\$0.00	YES	\$372.00
4	0.47	3393	0.09	300	0.630	366	0	\$0.00	YES	\$65.11	NO	\$0.00
5	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
7	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	2.14	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	3.15	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.42	3393	0.08	271	0.569	330	0	\$0.00	YES	\$65.11	NO	\$0.00
12	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	4.32	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	1.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.98	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	3.75	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	1.26	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	3.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
20	0.21	3393	0.04	135	0.284	165	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.31	3393	0.06	200	0.420	244	0	\$0.00	YES	\$65.11	NO	\$0.00
22	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.36	3393	0.07	230	0.482	280	0	\$0.00	NO	\$0.00	YES	\$372.00
25	0.21	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
25	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
26	1.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	5.70	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
28	1.34	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
29	5.79	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
29	10.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
30	5.27	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	64.525		0.53751	1412.944	2.96718	1723.792	2	\$792.34		\$260.44		\$1,116.00
Total \$ Expense = \$2,168.78												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G401LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

EXIT SIGNS: 20

BUILDING NUMBER: 401

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	11	4x2-2 lamp fluorescent	on	yes	no	3	no
1	1	8'-2 lamp fluorescent	on	no	no	0	no
2	2	120 Watt Incandescent	off	yes	no	2	no
3	1	120 Watt Incandescent	off	yes	no	1	no
4	26	150 Watt Incandescent	on	yes	no	8	no
4	24	200 Watt Incandescent	on	yes	no	9	no
5	8	4x2-2 lamp fluorescent	on	yes	no	1	yes
6	3	75 Watt Incandescent	on	yes	no	2	yes
7	4	75 Watt Incandescent	on	yes	no	1	no
8	2	120 Watt Incandescent	on	yes	no	1	yes
9	6	120 Watt Incandescent	on	yes	no	1	no
10	4	120 Watt Incandescent	off	yes	no	1	no
11	4	75 Watt Incandescent	off	yes	no	1	no
12	6	4x2-2 lamp fluorescent	on	yes	no	1	yes
13	14	8'-2 lamp fluorescent	on	yes	no	3	no
14	38	4x2-2 lamp fluorescent	on	yes	no	4	no
14	12	120 Watt Incandescent	off	yes	no	1	no
15	38	4x2-2 lamp fluorescent	off	yes	no	4	no
15	12	120 Watt Incandescent	off	no	no	0	no
16	20	8'-2 lamp fluorescent	on	yes	no	4	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 246LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 246

Sheet 1 of 1

% Unnoc. lights: 19%

Gas Increase Factor 4.40E-04 MBtu/kWh

Cooling Factor (Energ 1.18

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
154	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
153	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
152	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
151	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
155	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
103	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
107	8.99	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
148	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
147	3.41	3393	0.65	2198	0.967	2594	0	\$0.00	NO	\$0.00	YES	\$372.00
149	0.16	3393	0.03	100	0.044	118	0	\$0.00	YES	\$65.11	NO	\$0.00
146	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
144	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
143	0.93	3393	0.18	600	0.264	707	0	\$0.00	NO	\$0.00	YES	\$372.00
142	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
141	0.36	3393	0.07	230	0.101	271	0	\$0.00	NO	\$0.00	YES	\$372.00
136	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
139	0.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
138	0.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
109	4.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.78	3393	0.15	500	0.220	590	0	\$0.00	NO	\$0.00	YES	\$372.00
111	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
115	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
113	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
116	1.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
124	5.27	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
119	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
120	0.62	3393	0.12	400	0.176	472	0	\$0.00	NO	\$0.00	YES	\$372.00
122	0.16	3393	0.03	100	0.044	118	0	\$0.00	YES	\$65.11	NO	\$0.00
123	0.31	3393	0.06	200	0.088	236	0	\$0.00	YES	\$65.11	NO	\$0.00
125	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
126	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
134	3.72	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
133	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
132	0.47	3393	0.09	300	0.132	354	0	\$0.00	YES	\$65.11	NO	\$0.00
131	0.47	3393	0.09	300	0.132	354	0	\$0.00	YES	\$65.11	NO	\$0.00
130	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
128	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	51.106		2.09969	7124.248	3.13467	8406.613	0	\$0.00		\$520.88		\$3,348.00
Total \$ Saved/Year		\$199.64	Total \$ Expense = \$3,868.88									

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G401LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 401

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 2.10E-03 MBtu/kWh
Cooling Factor (Energy) 1.22

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.98	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
1	0.12	3393	0.00	31	0.066	38	1	\$396.17	NO	\$0.00	NO	\$0.00
2	0.00	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	0.12	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	3.90	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	4.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.23	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
7	0.30	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.72	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.30	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	2.94	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	3.38	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	1.44	3393	0.00	374	0.786	457	2	\$792.34	NO	\$0.00	NO	\$0.00
15	3.38	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	1.44	3393	0.00	374	0.786	457	2	\$792.34	NO	\$0.00	NO	\$0.00
16	4.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	30.214		0	780	1.638	951.6	5	\$1,980.85		\$0.00		\$0.00
Total \$ Expense = \$1,980.85												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 512LITE.WK3

PREPARED BY: JW

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY: CEL

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 30

BUILDING NUMBER: 512

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	43	8'-2 lamp fluorescent	on	no	no	0	no
2	4	8'-2 lamp fluorescent	on	yes	yes	1	yes
3	4	8'-2 lamp fluorescent	on	yes	no	2	no
4	4	8'-2 lamp fluorescent	on	no	no	0	no
4	4	4x2-4 lamp fluorescent	on	yes	no	2	no
5	12	4x2-4 lamp fluorescent	on	yes	no	2	no
1	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
6	67	8'-2 lamp fluorescent	on	no	no	0	no
7	3	8'-2 lamp fluorescent	on	yes	no	1	yes
8	3	8'-2 lamp fluorescent	on	yes	no	1	no
9	1	4x2-4 lamp fluorescent	on	yes	no	1	no
10	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
11	70	8'-2 lamp fluorescent	on	no	no	0	no
11	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
12	106	8'-2 lamp fluorescent	on	no	no	0	no
12	5	4x2-4 lamp fluorescent	on	no	no	0	no
12	6	4x2-4 lamp fluorescent	off	no	no	0	no
13	4	8'-2 lamp fluorescent	on	yes	no	1	no
14	2	8'-2 lamp fluorescent	on	yes	no	1	yes
15	22	8'-2 lamp fluorescent	on	no	no	0	yes
16	23	4x2-2 lamp fluorescent	on	yes	no	3	no
17	44	4x2-2 lamp fluorescent	on	no	no	0	no
18	9	4x2-2 lamp fluorescent	on	yes	no	6	yes
19	4	8'-2 lamp fluorescent	on	yes	yes	1	yes
11	6	4x2-2 lamp fluorescent	off	no	no	0	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 512LITE.WK3

PREPARED BY: JW

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY: CEL

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 512

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 4.13E-04 MBtu/kWh
Cooling Factor (Energy) 0

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	9.03	3393	0.00	2348	0.970	0	8	\$3,169.36	NO	\$0.00	NO	\$0.00
2	0.84	3393	0.16	542	0.224	0	0	\$0.00	NO	\$0.00	YES	\$372.00
3	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.84	3393	0.00	218	0.090	0	1	\$396.17	NO	\$0.00	NO	\$0.00
4	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
1	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	14.07	3393	0.00	3658	1.511	0	12	\$4,754.04	NO	\$0.00	NO	\$0.00
7	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	14.70	3393	0.00	3822	1.578	0	12	\$4,754.04	NO	\$0.00	NO	\$0.00
11	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	22.26	3393	0.00	5788	2.390	0	18	\$7,131.06	NO	\$0.00	NO	\$0.00
12	0.78	3393	0.00	202	0.083	0	1	\$396.17	NO	\$0.00	NO	\$0.00
12	0.93	3393	0.00	242	0.100	0	1	\$396.17	NO	\$0.00	NO	\$0.00
13	0.84	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.42	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	4.62	3393	0.00	1201	0.496	0	4	\$1,584.68	NO	\$0.00	NO	\$0.00
16	2.05	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	3.92	3393	0.00	1018	0.421	0	8	\$3,169.36	NO	\$0.00	NO	\$0.00
18	0.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.84	3393	0.16	542	0.224	0	0	\$0.00	NO	\$0.00	YES	\$372.00
11	0.53	3393	0.00	139	0.057	0	1	\$396.17	NO	\$0.00	NO	\$0.00
Total	82.531		0.3192	19718.55	8.14376	0	66	\$26,147.22		\$0.00		\$744.00
Total \$ Expense = \$26,891.22												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 935LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 8

BUILDING NUMBER: 935

Sheet 1 of 1

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	36	400 Watt Incandescent	on	yes	no	1	no
2	6	400 Watt Incandescent	on	yes	no	1	no
3	6	400 Watt Incandescent	on	yes	no	1	no
4	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
5	2	75 Watt Incandescent	on	no	yes	0	yes
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
8	1	150 Watt Incandescent	on	yes	yes	1	yes
9	9	4x2-2 lamp fluorescent	on	yes	no	2	yes
10	8	150 Watt Incandescent	on	yes	yes	2	yes
2a	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
11	9	4x2-2 lamp fluorescent	on	yes	yes	2	yes
13	4	200 Watt Incandescent	on	yes	no	1	yes
14	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
15	1	4x2-2 lamp fluorescent	off	yes	no	1	yes
16	3	4x2-2 lamp fluorescent	on	yes	no	2	yes
17	30	4x2-2 lamp fluorescent	on	yes	no	3	no
18	15	4x2-2 lamp fluorescent	off	yes	yes	3	no
19	10	4x2-2 lamp fluorescent	off	yes	yes	2	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 935LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

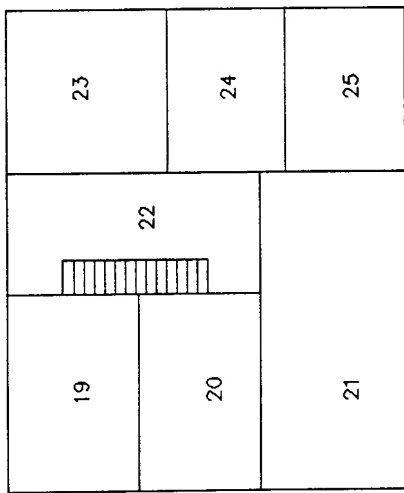
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 935

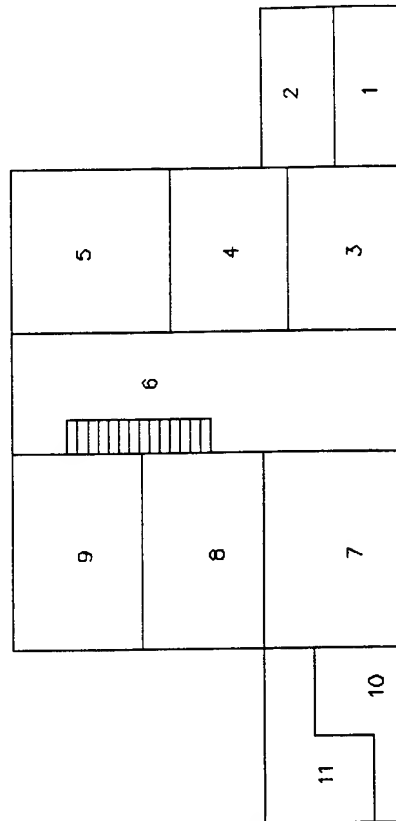
Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 1.27E-03 MBtu/kWh
Cooling Factor (Energy) 1.3375

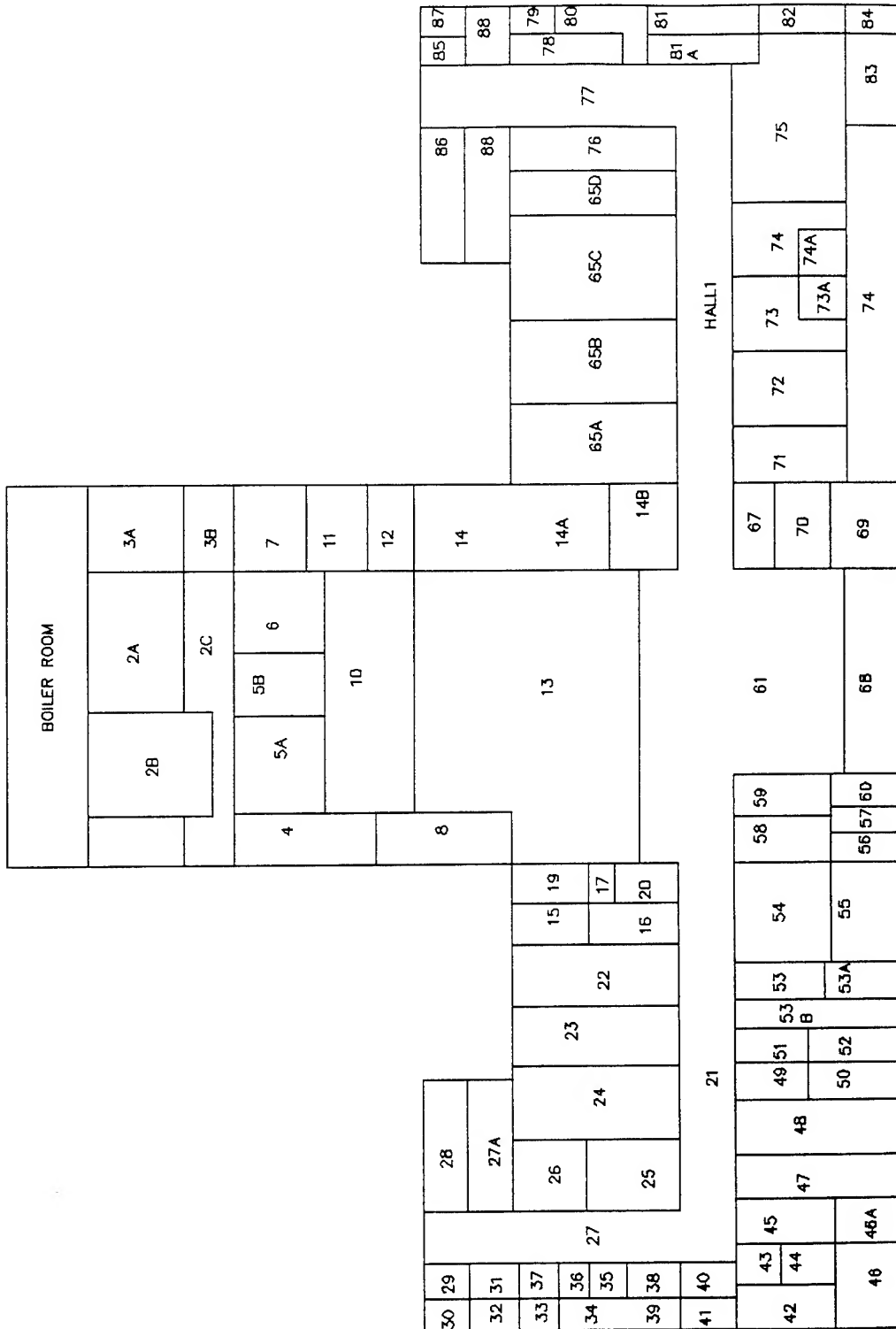
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	14.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.31	3915	0.06	81	0.102	108	1	\$396.17	YES	\$65.11	NO	\$0.00
5	0.15	3915	0.03	39	0.050	52	1	\$396.17	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
8	0.15	3915	0.03	112	0.142	149	0	\$0.00	YES	\$65.11	NO	\$0.00
9	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	1.20	3915	0.23	893	1.134	1194	0	\$0.00	NO	\$0.00	YES	\$372.00
2a	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
11	0.80	3915	0.15	596	0.757	797	0	\$0.00	NO	\$0.00	YES	\$372.00
13	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.62	3915	0.12	461	0.586	617	0	\$0.00	NO	\$0.00	YES	\$372.00
15	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	2.67	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	1.34	3915	0.25	993	1.261	1328	0	\$0.00	NO	\$0.00	YES	\$372.00
19	0.89	3915	0.17	662	0.841	885	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	30.351		1.23956	4630.306	5.88049	6193.035	2	\$792.34		\$455.77		\$1,860.00
Total \$ Expense = \$3,108.11												



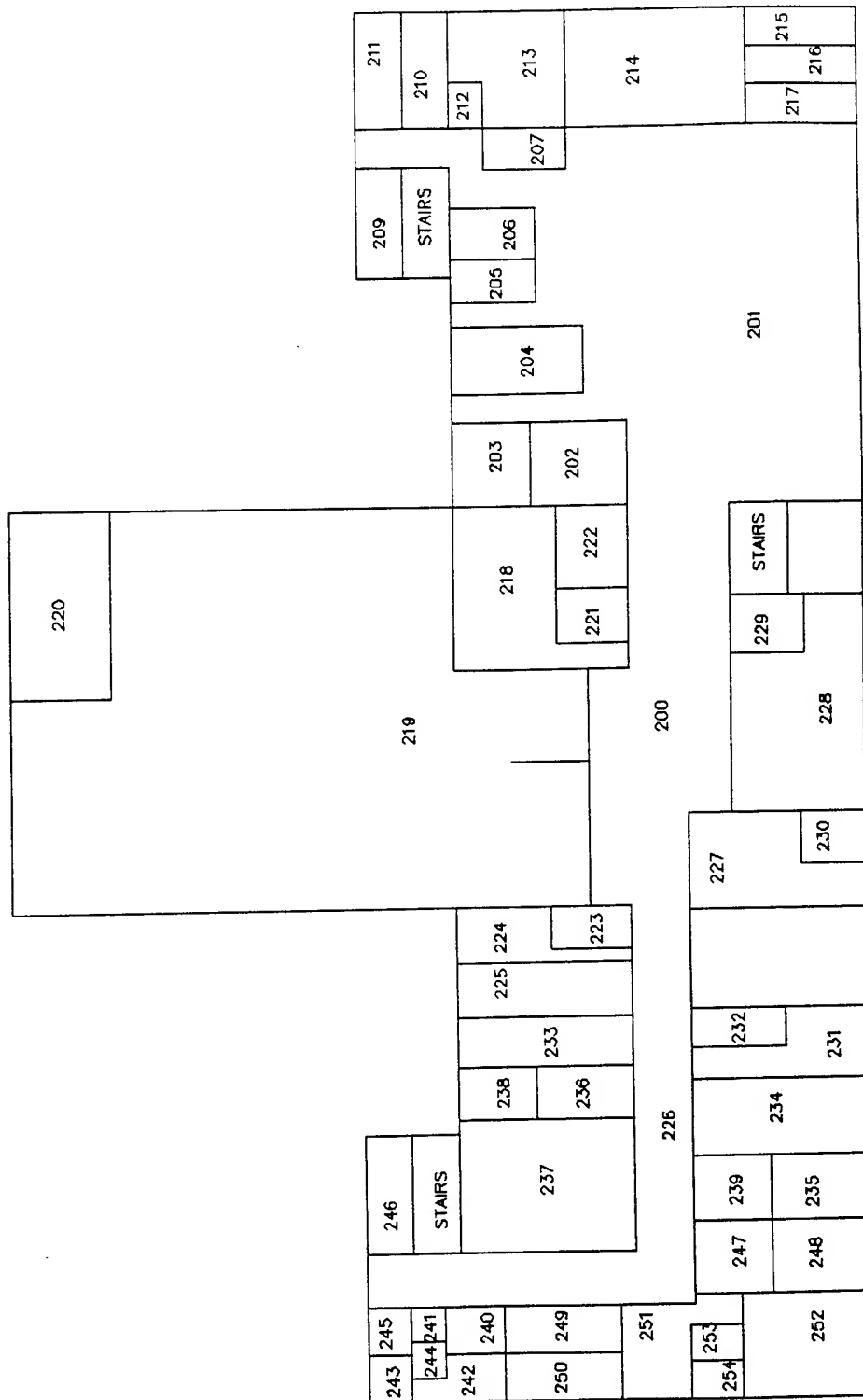
SECOND FLOOR
 NTS



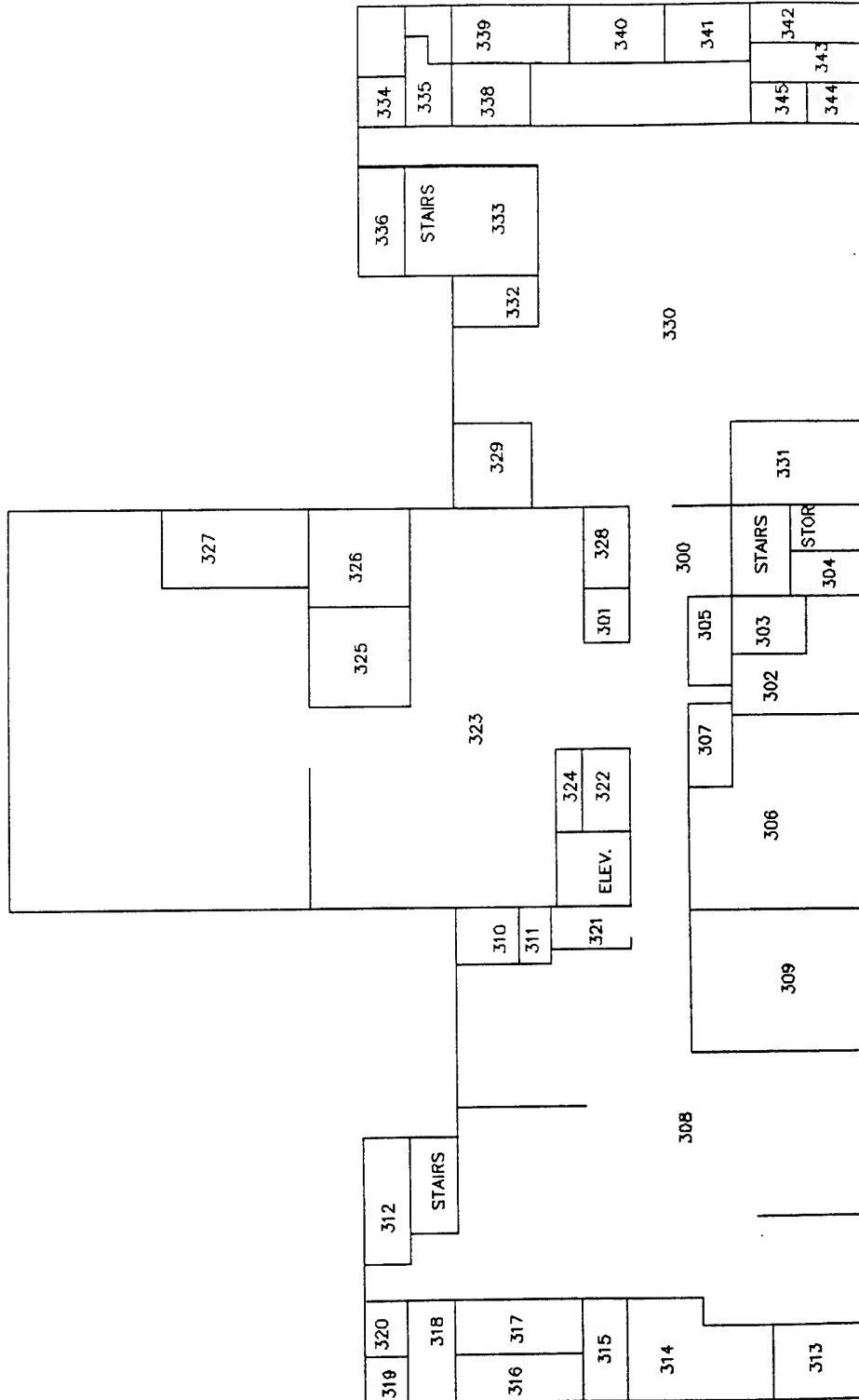
FIRST FLOOR
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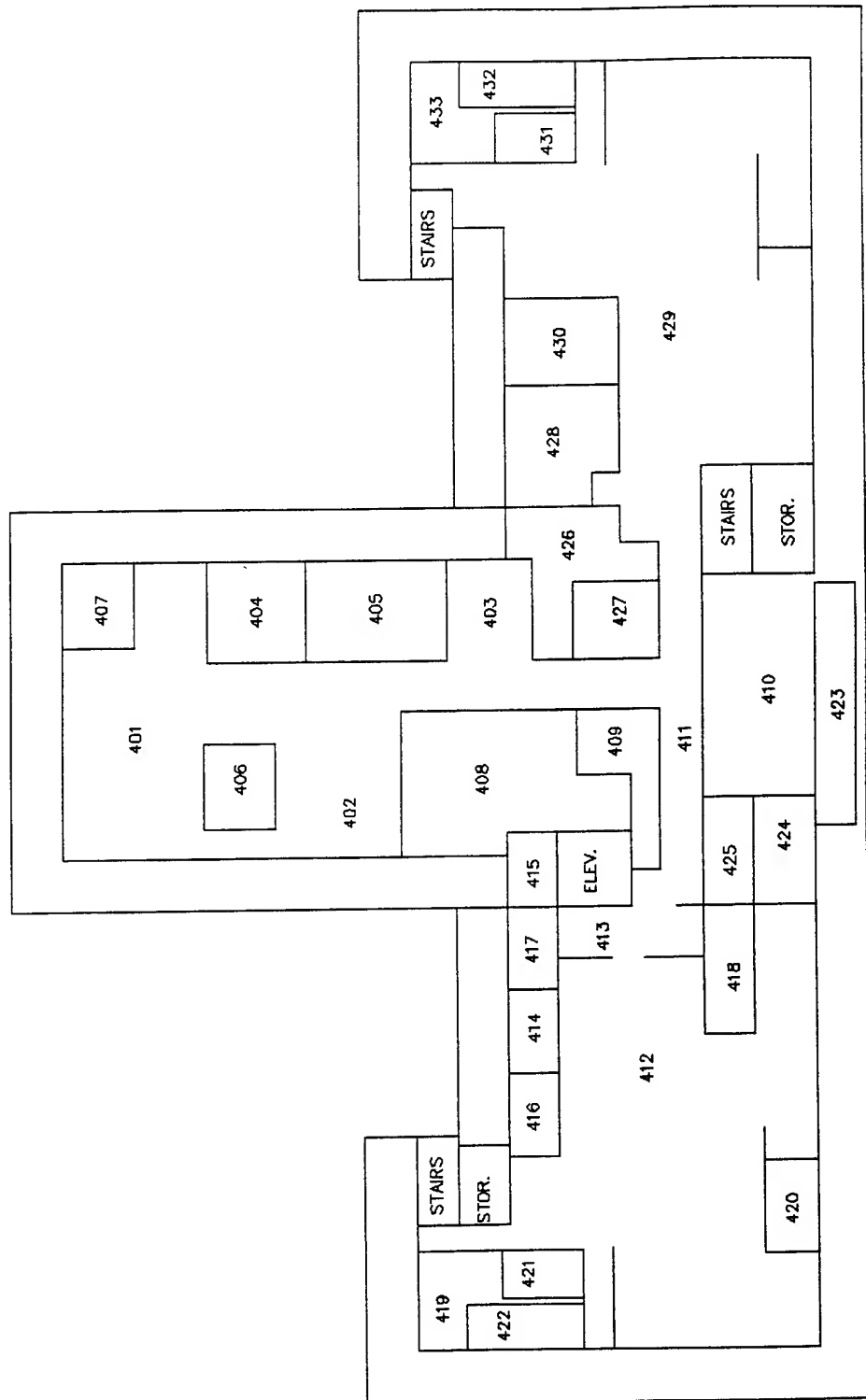
FIRST FLOOR
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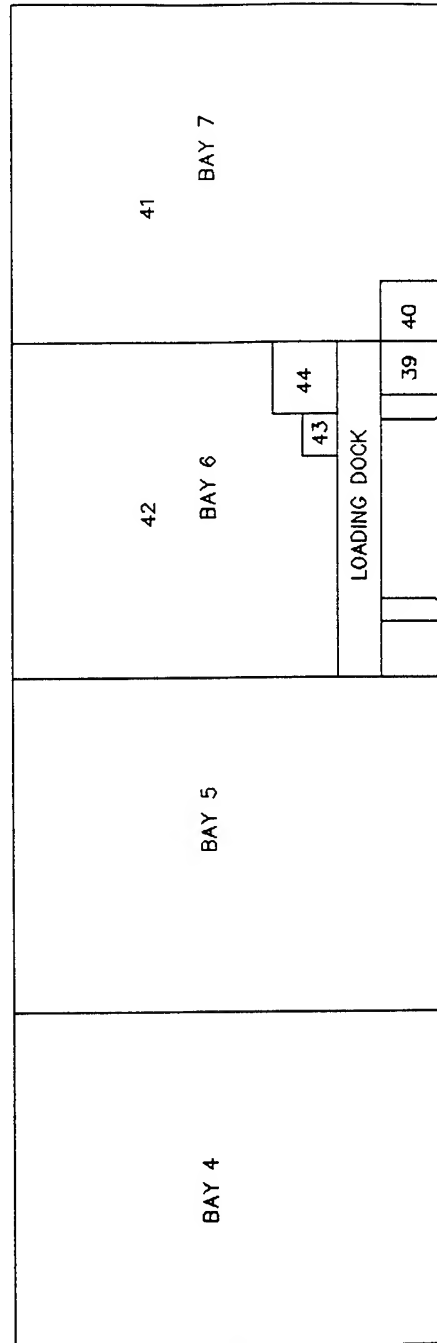
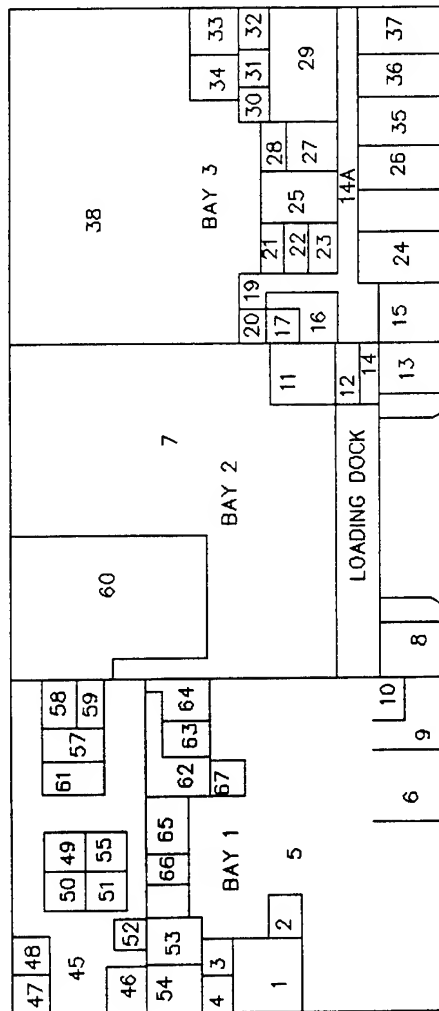
SECOND FLOOR
 NTS



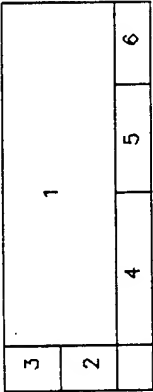
THIRD FLOOR
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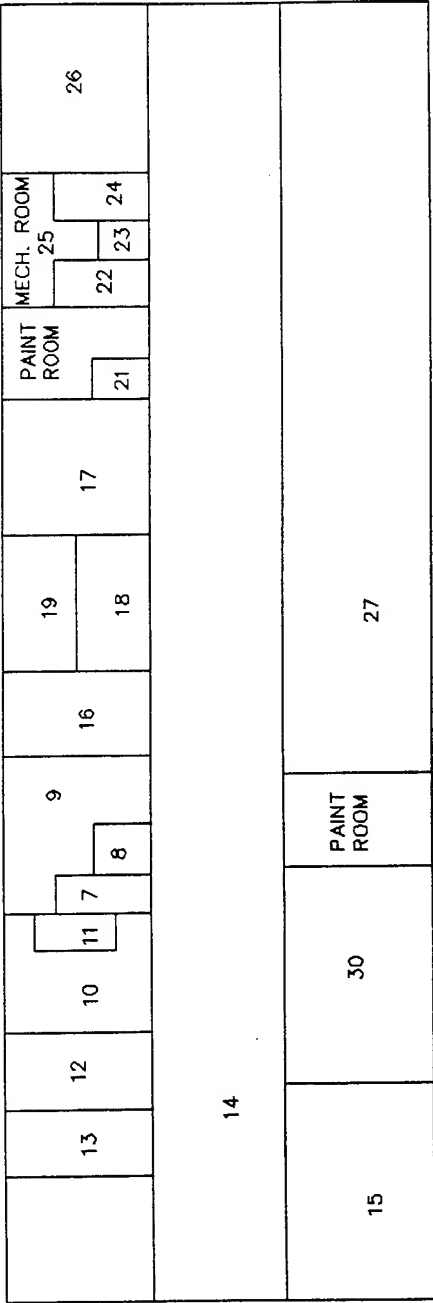
FOURTH FLOOR
 NTS



FLOOR PLAN
 NTS



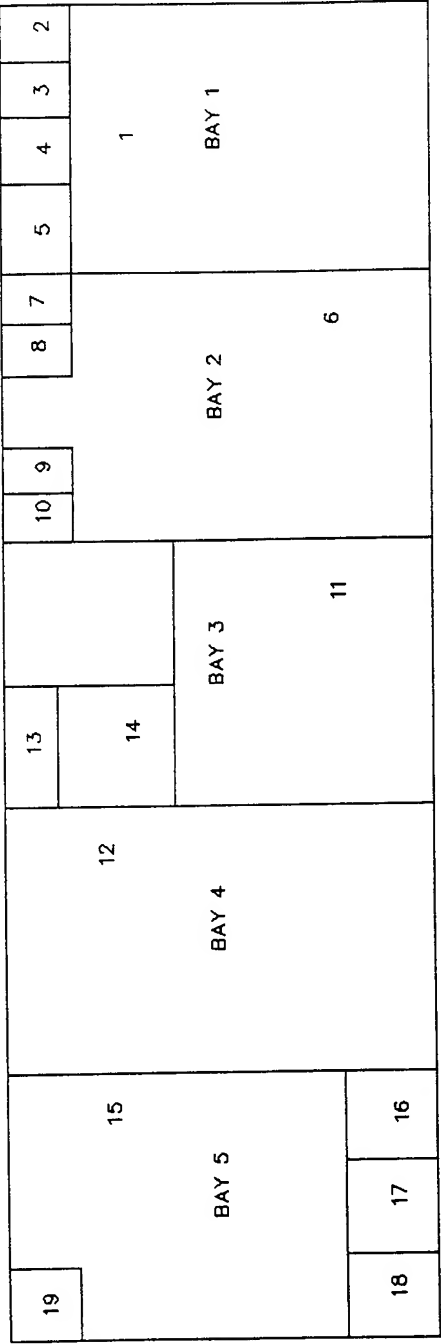
MEZZANINE LEVEL
NTS



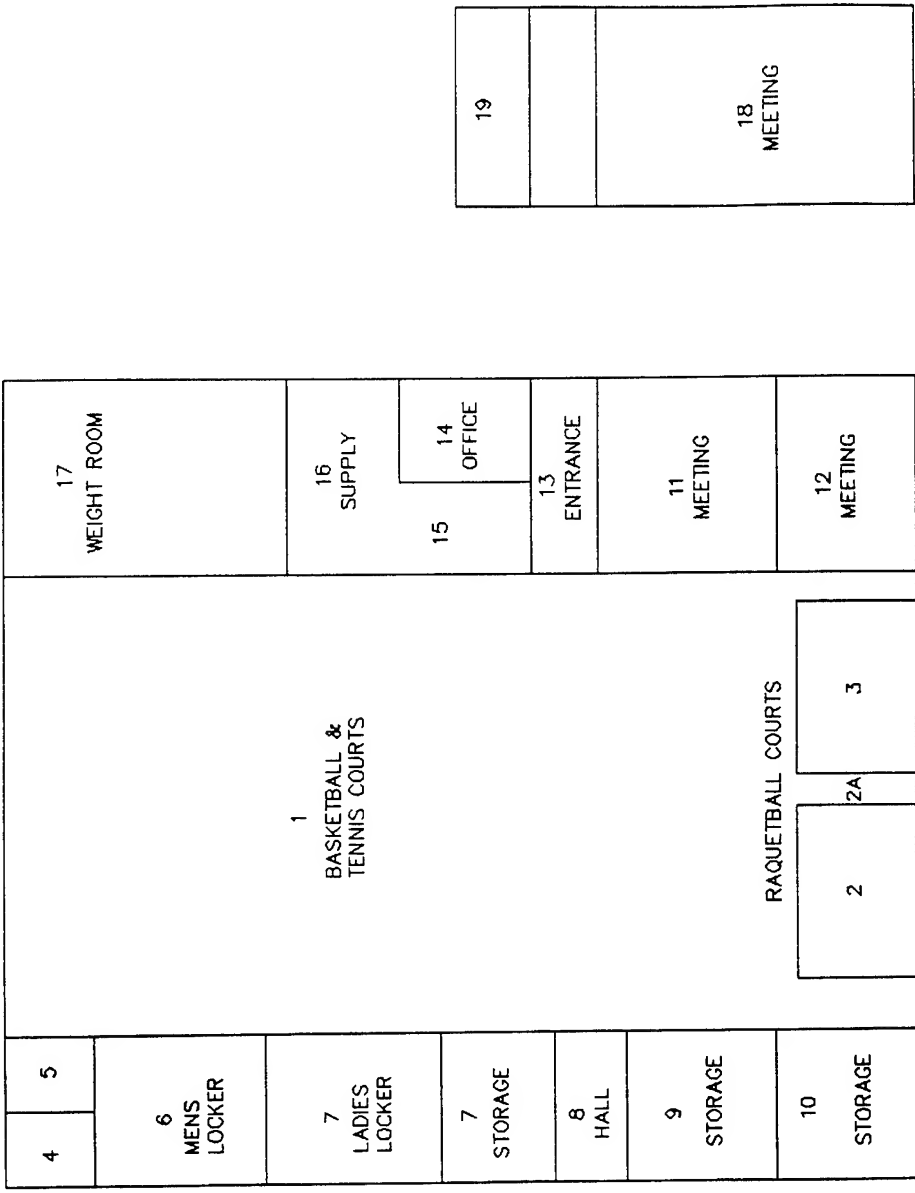
FIRST LEVEL
NTS







FLOOR PLAN
NTS



SECOND FLOOR
NTS

FLOOR PLAN
NTS

APPENDIX C-16

INVESTIGATE POST DEMAND USAGE

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 28-JAN-92

FILE: DUCTPIPE.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

FORT GILLEM ELECTRICAL DEMAND

JANUARY 1991

DECIMAL TIME	1/19/91	1/20/91	1/21/91	1/22/91	1/23/91	1/24/91	1/25/91	AVERAGE WEEKDAY	AVERAGE WEEKEND
0.5	2227	2227	2179	2314	2506	2362	2246	2227	2321.4
1.0	2227	2227	2179	2304	2486	2323	2237	2227	2305.8
1.5	2246	2227	2179	2304	2496	2342	2246	2236.5	2313.4
2.0	2208	2218	2170	2323	2515	2314	2246	2213	2313.6
2.5	2227	2198	2160	2342	2477	2314	2237	2212.5	2306
3.0	2198	2179	2150	2323	2467	2314	2227	2188.5	2296.2
3.5	2218	2179	2112	2333	2515	2323	2208	2198.5	2298.2
4.0	2179	2179	2112	2323	2467	2294	2208	2179	2280.8
4.5	2227	2189	2131	2352	2534	2362	2246	2208	2325
5.0	2237	2179	2170	2496	2621	2496	2371	2208	2430.8
5.5	2342	2189	2170	2746	2832	2621	2669	2265.5	2607.6
6.0	2554	2198	2189	2880	2880	2717	2861	2376	2705.4
6.5	2899	2198	2198	3360	3274	3101	3274	2548.5	3041.4
7.0	3331	2198	2227	4166	4224	4118	4090	2764.5	3765
7.5	3427	2218	2246	4867	4906	4771	4694	2822.5	4296.8
8.0	3466	2237	2218	5232	5194	5107	4925	2851.5	4535.2
8.5	3494	2246	2227	5347	5251	5174	5050	2870	4609.8
9.0	3514	2246	2237	5376	5318	5270	5117	2880	4663.6
9.5	3571	2294	2256	5443	5280	5261	5165	2932.5	4681
10.0	3581	2304	2227	5434	5290	5270	5155	2942.5	4675.2
10.5	3610	2342	2285	5405	5386	5338	5174	2976	4717.6
11.0	3648	2390	2314	5405	5376	5299	5155	3019	4709.8
11.5	3638	2381	2314	5395	5338	5290	5146	3009.5	4696.6
12.0	3619	2381	2352	5290	5290	5280	5088	3000	4680
12.5	3466	2400	2352	5299	5290	5299	5059	2933	4659.8
13.0	3398	2400	2323	5328	5251	5280	5050	2899	4646.4
13.5	3216	2390	2333	5366	5251	5270	5030	2803	4650
14.0	3197	2371	2304	5299	5222	5203	4982	2784	4602
14.5	3053	2352	2294	5213	5155	5222	4867	2702.5	4550.2
15.0	2880	2371	2266	5184	5098	5270	4781	2625.5	4519.8
15.5	2851	2333	2285	5165	5050	5155	4790	2592	4489
16.0	2630	2314	2227	4846	4570	4579	4214	2472	4087.2
16.5	2534	2352	2227	4186	4880	3994	3494	2443	3756.2
17.0	2467	2314	2218	3792	3715	3552	3053	2390.5	3266
17.5	2429	2266	2208	3466	3370	3139	2755	2347.5	2987.6
18.0	2429	2275	2256	3187	3034	3034	2707	2352	2843.6
18.5	2419	2304	2352	2976	2890	2957	2698	2361.5	2774.6
19.0	2390	2304	2342	2861	2794	2918	2650	2347	2713
19.5	2371	2304	2352	2813	2746	2784	2611	2337.5	2661.2
20.0	2362	2294	2342	2774	2630	2746	2611	2328	2620.6
20.5	2333	2314	2342	2707	2602	2755	2554	2323.5	2592
21.0	2333	2285	2342	2688	2554	2736	2448	2309	2553.6
21.5	2275	2246	2362	2621	2486	2630	2333	2260.5	2486.4
22.0	2256	2218	2285	2573	2458	2554	2275	2237	2429
22.5	2256	2227	2352	2592	2438	2544	2275	2241.5	2440.2
23.0	2256	2198	2342	2563	2400	2496	2246	2227	2409.4
23.5	2227	2208	2333	2525	2352	2458	2256	2217.5	2384.8
24.0	2218	2170	2294	2515	2352	2448	2246	2194	2371

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 28-JAN-92

FILE: DUCTPIPE.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

FORT GILLEM ELECTRICAL DEMAND

JANUARY 1992

DECIMAL TIME	1/11/92	1/12/92	1/13/92	1/14/92	1/15/92	1/16/92	1/17/92	AVERAGE	AVERAGE
								WEEKDAY	WEEKEND
0.5	2266	2160	2045	2112	2438	2429	2477	2300.2	2213
1.0	2237	2179	2006	2122	2381	2419	2477	2281	2208
1.5	2237	2141	2016	2112	2371	2410	2458	2273.4	2189
2.0	2266	2179	2026	2093	2362	2429	2486	2279.2	2222.5
2.5	2275	2189	2016	2122	2352	2448	2496	2286.8	2232
3.0	2237	2189	2035	2093	2381	2458	2506	2294.6	2213
3.5	2266	2189	1997	2093	2400	2419	2506	2283	2227.5
4.0	2294	2170	1997	2074	2410	2486	2582	2309.8	2232
4.5	2275	2170	2006	2102	2410	2496	2544	2311.6	2222.5
5.0	2275	2170	2160	2237	2554	2621	2650	2444.4	2222.5
5.5	2323	2179	2285	2429	2746	2669	2678	2561.4	2251
6.0	2563	2179	2467	2582	2842	2746	2803	2688	2371
6.5	2880	2246	2938	2995	3226	3197	3254	3122	2563
7.0	3014	2314	3686	3869	4003	4090	4186	3966.8	2664
7.5	3062	2438	4358	4406	4608	4810	4858	4608	2750
8.0	3043	2419	4723	4781	4982	5184	5136	4961.2	2731
8.5	3110	2410	4762	4867	5078	5328	5242	5055.4	2760
9.0	3168	2448	4858	4973	5194	5328	5261	5122.8	2808
9.5	3206	2496	4886	5078	5251	5395	5290	5180	2851
10.0	3264	2506	4896	5088	5261	5405	5280	5186	2885
10.5	3254	2506	4848	5078	5213	5386	5222	5149.4	2880
11.0	3216	2515	4810	5098	5213	5395	5242	5151.6	2865.5
11.5	3197	2515	4771	5088	5184	5434	5232	5141.8	2856
12.0	3130	2486	4810	5098	5155	5386	5174	5124.6	2808
12.5	2755	2477	4800	5107	5155	5328	5126	5103.2	2616
13.0	2707	2448	4762	5098	5088	5309	5078	5067	2577.5
13.5	2669	2448	4762	5050	5059	5318	5040	5045.8	2558.5
14.0	2602	2429	4752	5069	5040	5290	5021	5034.4	2515.5
14.5	2525	2400	4733	5059	5040	5280	4992	5020.8	2462.5
15.0	2467	2362	4666	5050	4973	5155	4915	4951.8	2414.5
15.5	2448	2333	4598	4954	4906	5107	4838	4880.6	2390.5
16.0	2381	2304	4051	4483	4349	4541	4022	4289.2	2342.5
16.5	2362	2256	3418	3888	3754	3974	3350	3676.8	2309
17.0	2285	2189	3034	3466	3389	3562	2995	3289.2	2237
17.5	2246	2150	2822	3216	3168	3350	2803	3071.8	2198
18.0	2246	2179	2678	3043	2957	3091	2698	2893.4	2212.5
18.5	2275	2218	2582	2928	2918	2966	2717	2822.2	2246.5
19.0	2256	2189	2534	2832	2861	2918	2611	2751.2	2222.5
19.5	2237	2141	2477	2842	2803	2870	2544	2707.2	2189
20.0	2237	2131	2362	2774	2736	2851	2496	2643.8	2184
20.5	2227	2131	2304	2736	2746	2822	2486	2618.8	2179
21.0	2218	2122	2275	2688	2678	2707	2477	2565	2170
21.5	2179	2093	2227	2659	2611	2640	2410	2509.4	2136
22.0	2170	2064	2179	2515	2621	2602	2400	2463.4	2117
22.5	2160	2054	2141	2467	2621	2592	2381	2440.4	2107
23.0	2179	2056	2150	2458	2573	2534	2381	2419.2	2117.5
23.5	2170	2035	2122	2467	2506	2496	2362	2390.6	2102.5
24.0	2170	2035	2083	2448	2448	2467	2323	2353.8	2102.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

CO:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 28-JAN-92

FILE: DUCTPIPE.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

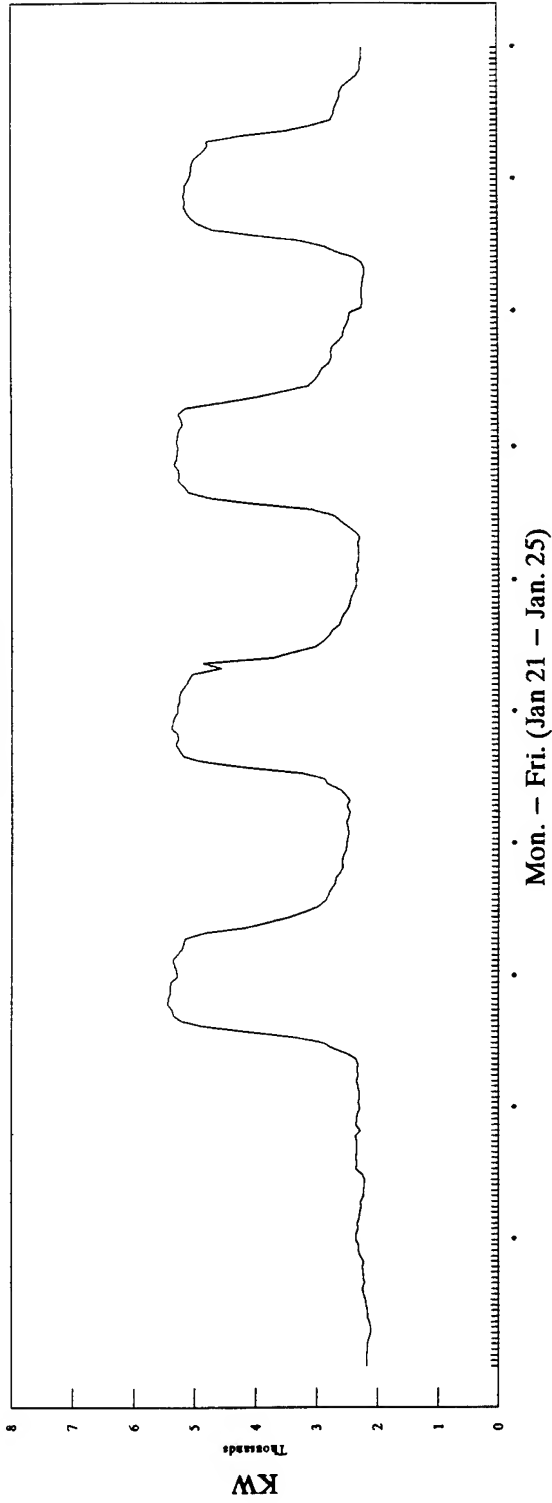
FORT GILLEM ELECTRICAL DEMAND

AUGUST 1992

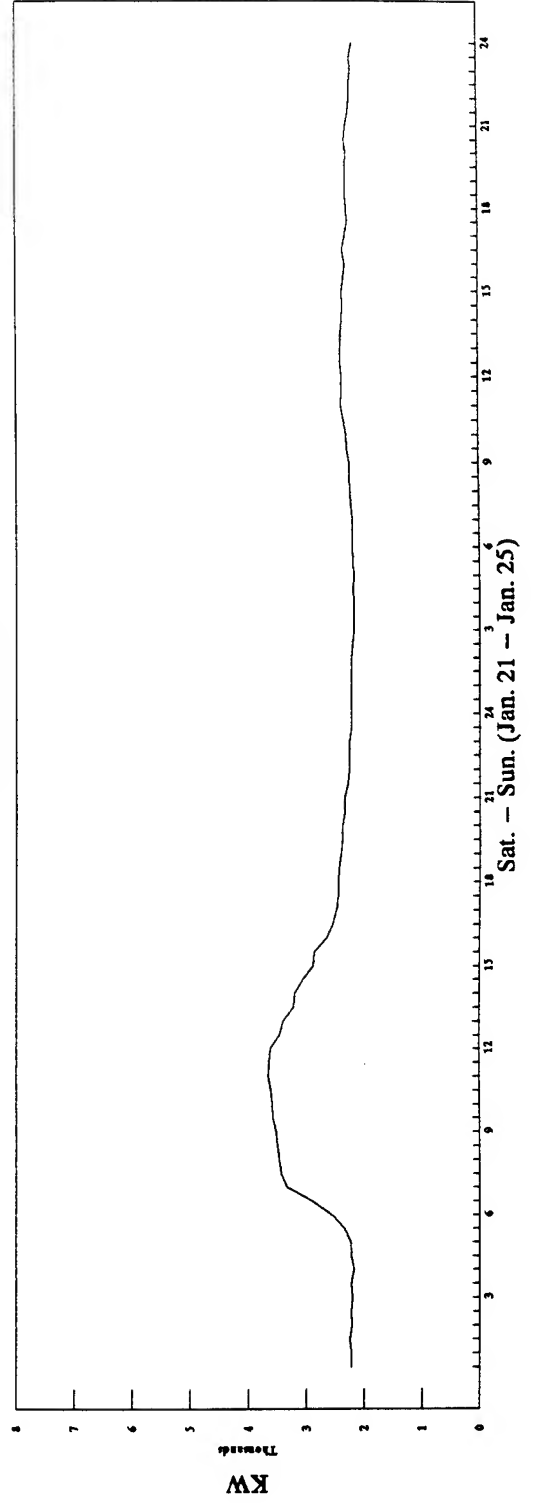
DECIMAL TIME	8/3/91	8/4/91	8/5/91	8/6/91	8/7/91	8/8/91	8/9/91	AVERAGE	AVERAGE
								WEEKDAY	WEEKEND
0.5	2947	2957	2928	3158	3254	3187	3283	1437.273	2952
1.0	2899	2928	2870	3139	3187	3149	3216	2091.4	2913.5
1.5	2861	2880	2832	3101	3139	3110	3178	2336.55	2870.5
2.0	2813	2832	2784	3034	3101	3062	3110	2472.88	2822.5
2.5	2755	2813	2813	3053	3139	3082	3101	2567	2784
3.0	2736	2822	2755	3014	3091	3082	3053	3066.833	2779
3.5	2765	2765	2746	2976	3043	3005	3043	3033.6	2765
4.0	2736	2755	2707	2976	2986	2995	3014	3004.167	2745.5
4.5	2726	2698	2736	2986	2966	3005	3053	2983.7	2712
5.0	2698	2698	2822	3072	3062	3110	3158	2988.133	2698
5.5	2669	2707	2947	3254	3206	3293	3302	3015.267	2688
6.0	2650	2650	2966	3283	3283	3370	3389	3058.467	2650
6.5	2688	2717	3350	3619	3658	3782	3754	3170.133	2702.5
7.0	2726	2678	4253	4483	4502	4646	4493	3426.767	2702
7.5	2669	2669	5011	5174	5126	5222	5165	3791.833	2669
8.0	2698	2678	5539	5626	5558	5731	5568	5604.4	2688
8.5	2832	2765	5798	5942	5808	6019	5933	5900	2798.5
9.0	3005	2832	5971	6115	5981	6144	6038	6049.8	2918.5
9.5	3101	2918	6106	6163	6144	6298	6230	6188.2	3009.5
10.0	3197	3043	6134	6307	6202	6403	6307	6270.6	3120
10.5	3226	3139	6269	6403	6298	6499	6422	6378.2	3182.5
11.0	3312	3216	6307	6422	6336	6509	6509	6416.6	3264
11.5	3350	3264	6442	6566	6480	6566	6442	6499.2	3307
12.0	3350	3350	6480	6634	6538	6576	6374	6520.4	3350
12.5	3446	3370	6480	6672	6643	6614	6394	6560.6	3408
13.0	3485	3427	6528	6768	6653	6672	6480	6620.2	3456
13.5	3504	3475	6634	6787	6701	6730	6470	6664.4	3489.5
14.0	3533	3504	6643	6787	6653	6730	6490	6660.6	3518.5
14.5	3542	3590	6710	6835	6672	6768	6528	6702.6	3566
15.0	3629	3562	6730	6864	6710	6730	6547	6716.2	3595.5
15.5	3552	3542	6691	6749	6720	6634	6499	6658.6	3547
16.0	3562	3504	6086	6115	6192	6067	5693	6030.6	3533
16.5	3581	3494	5290	5261	5395	5242	4963	5230.2	3537.5
17.0	3514	3485	4790	4858	4867	4838	4541	4778.8	3499.5
17.5	3494	3418	4502	4560	4637	4560	4291	4510	3456
18.0	2446	3398	4205	4406	4397	4397	4186	4318.2	2922
18.5	3370	3360	4051	4234	4128	4195	3994	4120.4	3365
19.0	3264	3302	3888	4022	3965	4090	3734	3939.8	3283
19.5	3226	3245	3830	3926	3878	3974	3581	3837.8	3235.5
20.0	3149	3178	3706	3888	3782	3888	3379	3728.6	3163.5
20.5	3178	3139	3686	3830	3706	3782	3293	3659.4	3158.5
21.0	3158	3139	3677	3725	3696	3686	3283	3613.4	3148.5
21.5	3178	3158	3571	3590	3571	3610	3178	3504	3168
22.0	3149	3120	3485	3485	3533	3533	3130	3433.2	3134.5
22.5	3062	3043	3379	3379	3456	3485	3082	3356.2	3052.5
23.0	3034	3062	3341	3389	3312	3408	3034	3296.8	3048
23.5	3005	2976	3283	3322	3283	3350	3024	3252.4	2990.5
24.0	3005	2966	3197	3274	3235	3293	2947	3189.2	2985.5

JANUARY 1991

WEEKDAYS

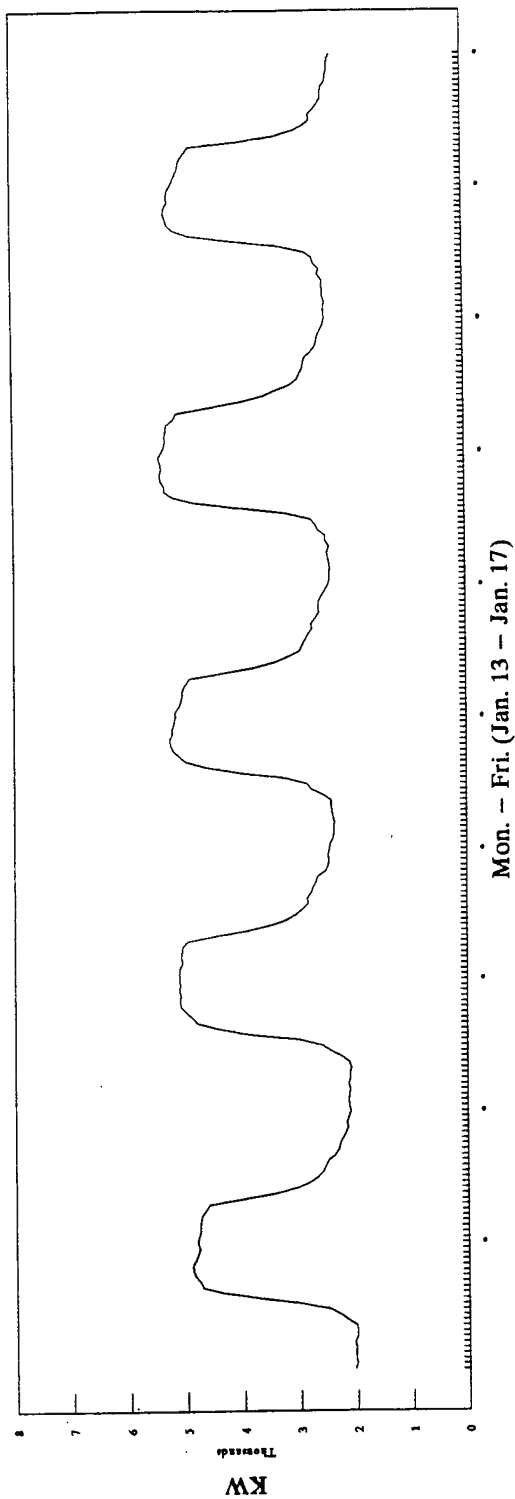


WEEKEND

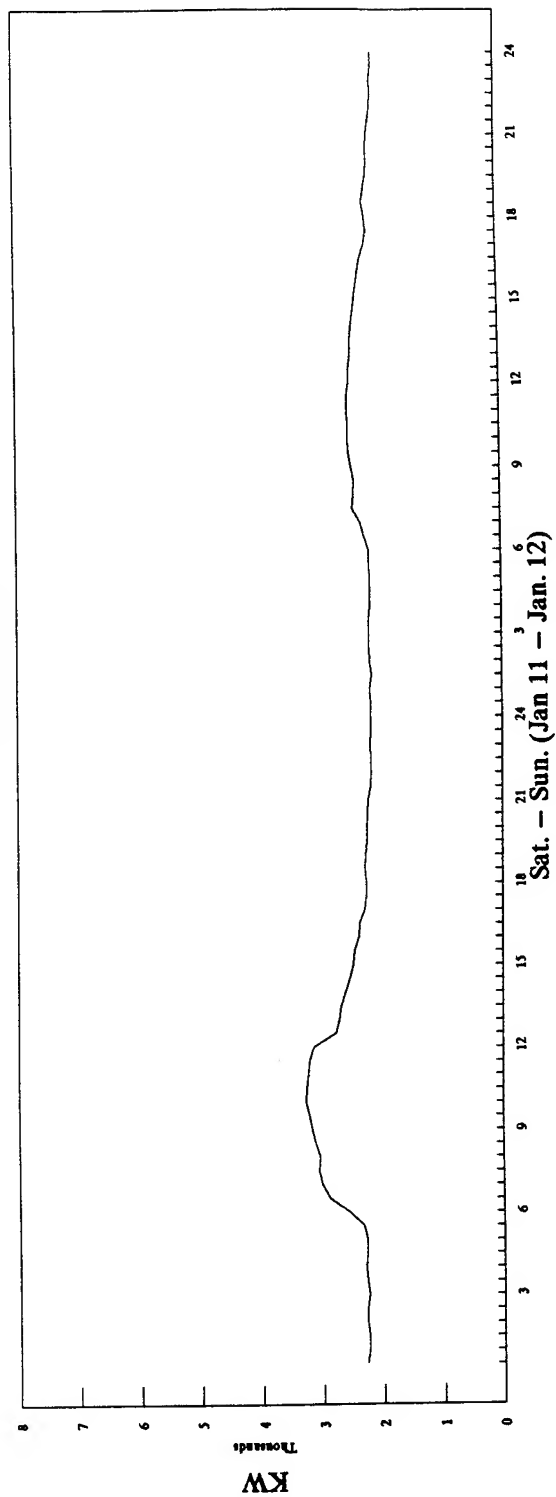


JANUARY 1992

WEEKDAYS

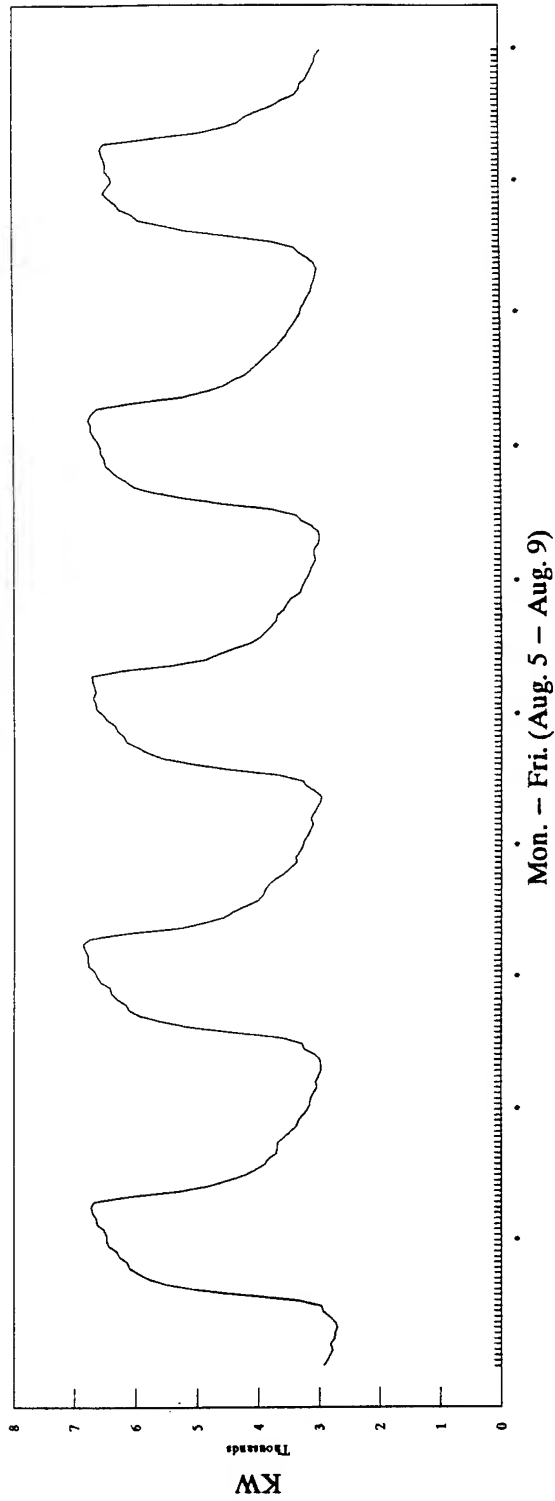


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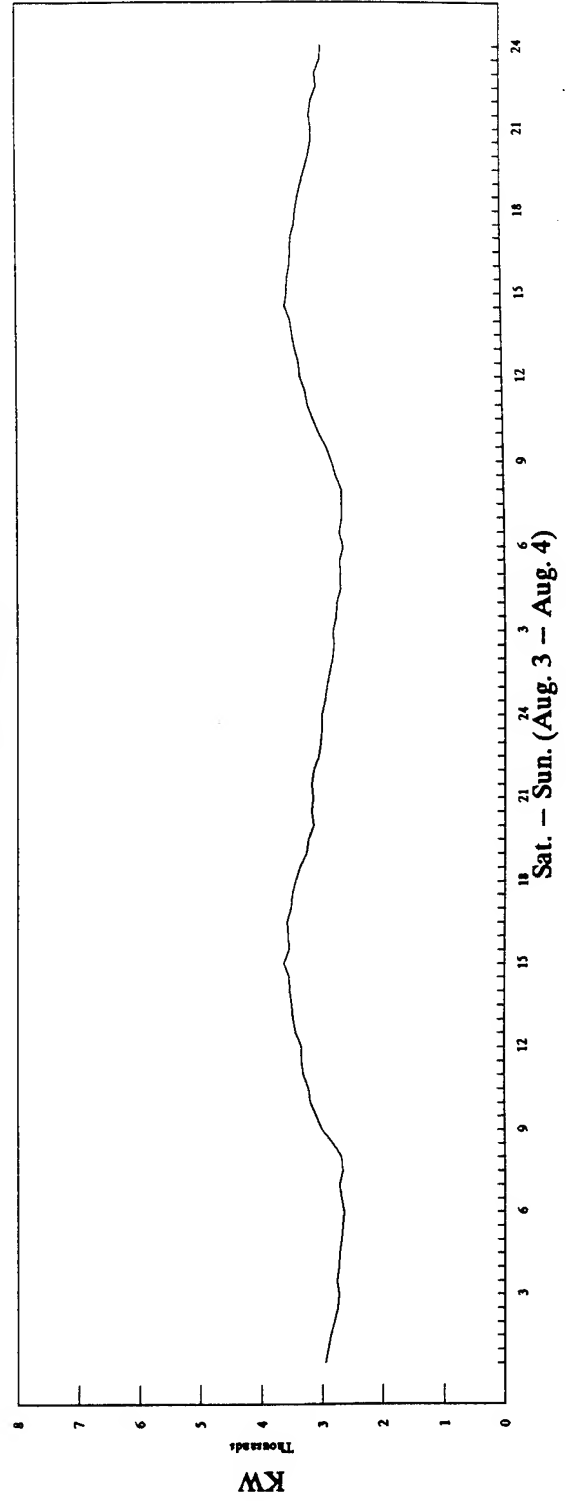


AUGUST 1992

WEEKDAYS



WEEKEND



Scientific Atlanta

Control Systems Division - Box J05038 Atlanta, GA 30348 Telephone 404 441-4000, TWX 810-766 4912, Telex 0542898, ITT 4611081

April 17, 1992

Mr. Carl Lunstrom
EMC Engineers, Inc.
1950 Spectrum Circle
Suite B-312
Marietta, GA 30067

Dear Carl:

I apologize for the delay in sending you the information you requested recently. We do appreciate your interest in our products, and I really do try to give faster attention to inquiries such as yours. As we discussed, Scientific-Atlanta is a leading manufacturer of radio operated load management systems.

I am enclosing several data sheets to describe a system which would be suitable for Fort McPherson. We can offer a turn-key service to provide and install the head-end equipment, including the transmitter, as well as provide technical support in arranging for installation of the radio switches, which we call DCUs (Digital Control Units). As you know, most military bases would prefer to farm out the labor for installation of these systems.

Budgetary pricing is as follows:

LMC-1041+ Load Management Controller:	\$25,000.00
Transmitter and Xtr Controller:	\$10,000.00
DCU Radio Switches:	\$ 100.00 ea.
Start up and training:	\$ 4,000.00
Portable Test Unit:	\$ 495.00

I will ask Dick Preston, the regional sales manager for this area, to contact you and provide any further information you may desire. Thanks again for your interest in our products.

Yours truly,

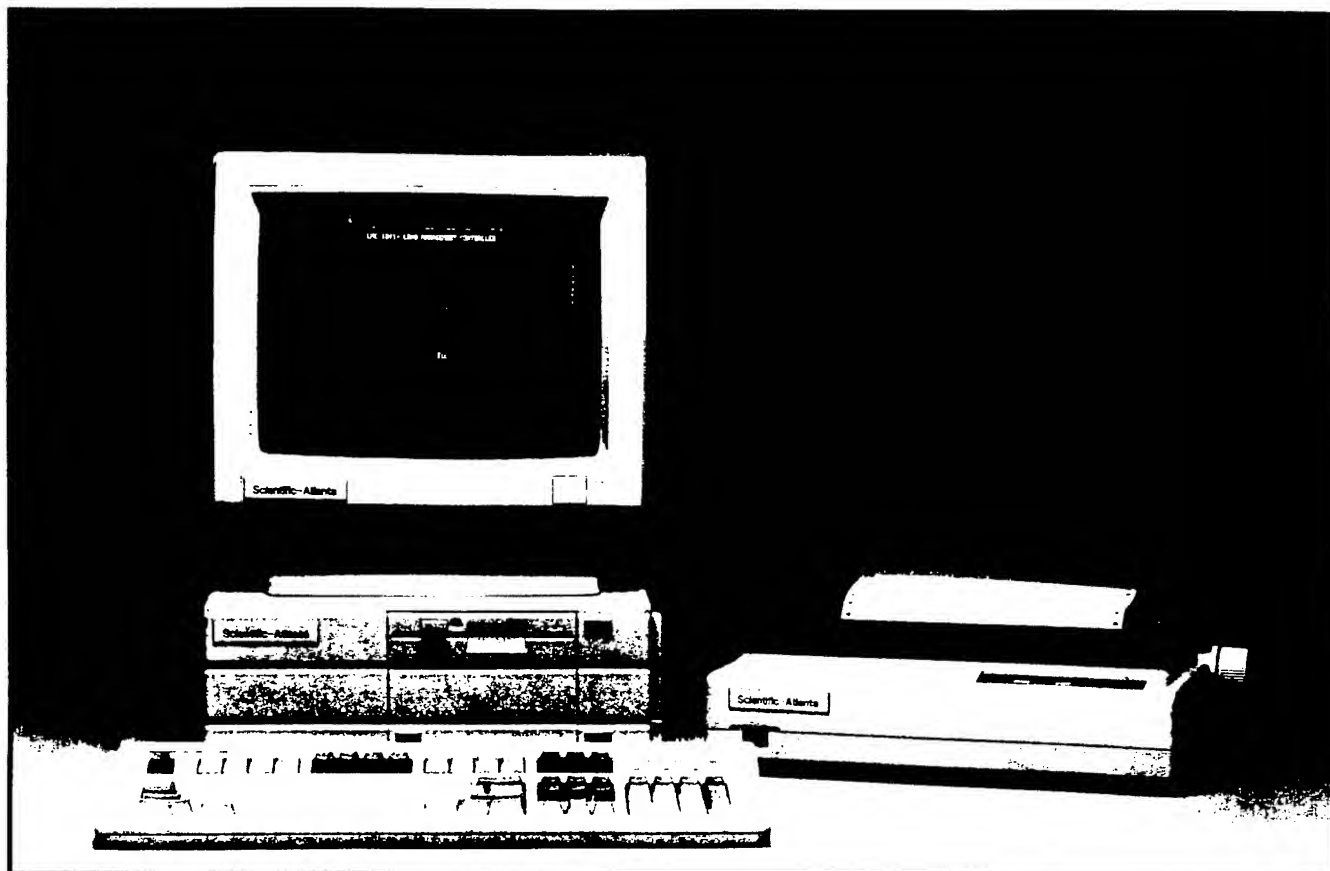


G. Burns Porter
Applications Engineering Manager

GBP/sjb

Enclosures

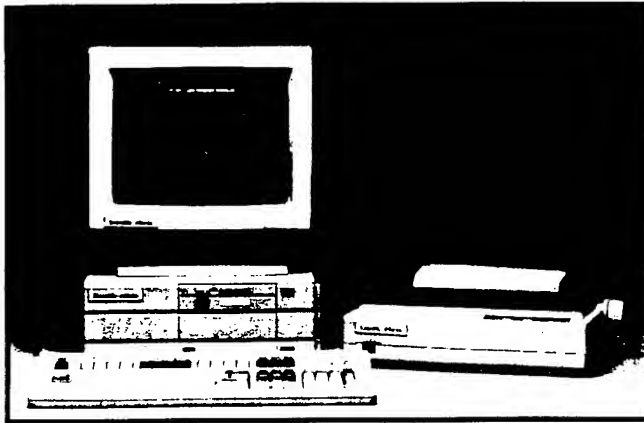
cc: Dick Preston



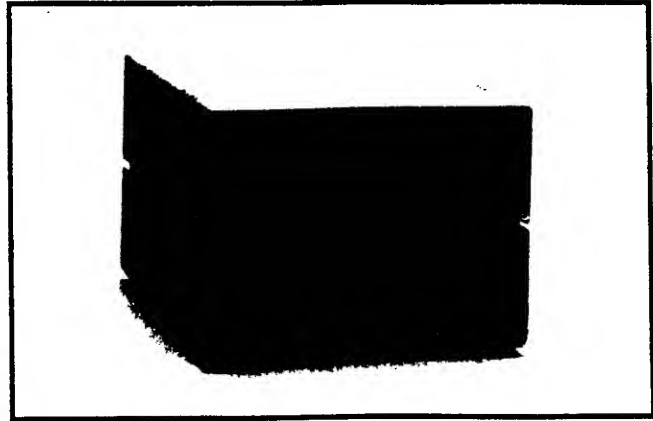
Features

- Combines data acquisition and load control into one machine operating on MS-DOS
- Manual or automatic initiation of load control
- Several load control algorithms are available to the user
- Generates messages in several formats of radio controlled switches
- Program is simple, yet flexible
- Controls air conditioners, water heaters, irrigation pumps, and capacitor banks
- User can define the control "steps" that the program uses
- All programming is done with pop-up menus and operator prompts with on-screen helps
- User defines the number of addresses, number of control groups and strategies he wants and the LMC creates file space to accommodate, limited only by available memory
- Operating characteristics can be modified while the program is running
- Special screens can easily be designed and implemented by the user
- Software supports an optional color monitor
- All software is stored on a hard disk
- Lotus®- compatible historical data files allow easy processing of accumulated data
- Printer can be programmed to automatically print reports
- System automatically restarts in case of power outage
- Interfaces to Scientific-Atlanta's Remote Transmitter Controllers RTC-1032 or RCCA-1002A
- Optional WWV interface ensures accurate timekeeping
- Software supports bar chart and line graphics

Model LMC-1041+ Load Management Controller



LMC 1041+, Load Management Controller



RTC-1032, Remote Transmitter Controller

Description

The LMC-1041+ is a personal computer based load management controller and data acquisition system. Automatic or manual control commands are initiated by the LMC-1041+ to remotely installed radio receivers. The receivers control loads such as air conditioners, water heaters, pool pumps, irrigation pumps, etc. Power factor control is also possible by remotely controlling distribution feeder capacitor banks.

Data acquisition capabilities of the LMC-1041+ permit monitoring of substation data for display and/or initiation of automatic control functions. Automatic control can be done using kW or kVAR inputs, status point closures, and/or time-of-day and day-of-week schedules.

Capable of outputting all standard Scientific-Atlanta code formats as well as a number of others, the LMC-1041+'s flexible software permits the user to easily configure the system by selecting the options he wants from the pop-up menus, lists of valid entries, and notes which briefly explain what each entry does.

An unlimited number of load groups as well as multiple load control algorithms, time-of-day schedules and control strategies provide ultimate flexibility. The user can even modify existing displays or create new displays to meet his needs using the LMC-1041+ display editor. With this capability he can display the most important "real-time" and explanatory information.

The LMC-1041+ places no limit on the number of strategies, load groups, or switch addresses the utility may use. The user tells the LMC what he wants to do and the LMC creates file space to meet the user's needs. The only limit is the amount of memory available.

The LMC-1041+ program is organized by strategies, setpoints, status points and time-of-day schedules. The user can then apply these characteristics to increase or decrease the amount and type of load to be shed and restored to meet changing control requirements. The user can call for load control algorithms such as cycling at a designated percentage, on/off control, various dis-

tributed intelligence strategies, nicking or SCRAM. These can be used in virtually any combination to meet the user's control needs.

The LMC-1041+ also has several features which support the user in operating the system and reporting what has happened. All information can be formatted into a Lotus® compatible file and stored on the hard disk. The printer can be programmed to print out any or all events such as alarms or the automatic initiation of load control.

The LMC-1041+ also uses Scientific-Atlanta's Remote Transmitter Controller (RTC-1032) in this system. An RTC-1032 is located at each transmitter site, connected to the LMC through 1200 baud modems. The RTC-1032 (formerly the RCCA-1002A) receives the messages to be broadcast from the LMC, stores those messages until its proper time slot, keys the transmitter, then generates the proper modulation (tones or shifting frequency) to represent the message.

The RTC can generate most of the formats used in load control today. These include single tone, two tone, Scientific-Atlanta's digital, 100, 102, SA-105 and SA-205 AFSK formats, and the Golay 23, 12 FSK format.

The RTC can control up to six groups of transmitters (for time slot coordination with other utilities). If a carrier-operated relay is in the transmitter, the RTC can also wait until the air clears before broadcasting.

The LMC-1041+ is typically quoted with the standard hardware shown in the specifications section. The RTC's and modems are quoted separately because each system may require different numbers of transmitters.

Specifications

LMC-1041+ Hardware

- Personal computer running on MS-DOS operating system with enhanced keyboard and 640K of RAM
- 13" Color Monitor
- 3 1/2" 720K floppy disk drive
- 20 MB hard disk
- Dot matrix printer
- Serial port
- Parallel port
- Data acquisition board and connector panel with 8 analog inputs, 8 status inputs, and 8 contacts out
- All interfaces and cables required
- Hardware Options:
 1. Up to 24 analog inputs, 24 status inputs, and 24 contacts out

LMC-1041+ Software

• Load control

1. Strategies

- a. Up to 1000 allowed
- b. One or more running at the same time
- c. Up to 100 load control steps per strategy
- d. Direction of the steps can be changed whether in shed or restore mode
- e. Strategies can be tied to any combination of four status points, analog demands, or time-of-day schedules for automatic initiation of load control
- f. And/or conditionals enhance initiation factors
- g. Strategy activation can be automatic (tied to activation parameters), continuous (constantly active), or in SCRAM mode (to select 100% shed of all points)

2. Steps

- a. Three types of steps (activation of switch groups, closing control points, or resetting strategy activation level to a new point)
- b. Automatic, continuous, or SCRAM activation of any step
- c. Steps can be linked to make them happen at the same time in either the shed or restore direction.
- d. Information going to the historical data files can be turned on and off

3. Switch Group Steps

- a. Switch control algorithms
 - Sequential step (on/off in the same order each time)
 - Rotational step (on/off in rotating order)
 - Gradual time cycle (achieve designated % over one time-out period)

- Fast time cycle (achieve designated % in one burst of messages)
 - Target % load shed (responds to changes in demand level)
 - Nicking (for testing the effectiveness of load control)
 - 102 commands (repeating direct load control)
 - SA-105 and SA-205 commands (distributed intelligence control)
- b. Maximum load shed % for this switch group
 - c. Maximum duration of load control for the switch group
 - d. Time that the appliance must remain on after reaching its maximum duration before it can be controlled again
 - e. Time-out, cycle time and number of repetitions selections in the 102, SA-105 and SA-205 format switches.

4. Switch Groups

- a. Up to 1000 addresses per group
- b. Group assigned to a single or all transmitters
- c. Repeat number of messages sent each time (1 or more)
- d. Minimum, nominal, and virtual time-outs

5. Addresses

- a. Individual addresses can be enabled or disabled
- b. Messages sent can be recorded in a data file
- c. Nine different formats are supported (SA timeout, SA set/reset, single tone, two tone, Golay, 100, 102, SA-105 and SA-205)

6. Time-of-Day Schedules

- a. Schedule name
- b. Programmed for seven days plus holidays
- c. 4 start/stop intervals per day

7. Holiday Lists

- a. 20 days

8. Transmit Schedule and System Options

- a. Enable or disable transmissions during each minute of the hour (for coordination with other utilities)
- b. Time slotting for 1 to 6 transmitter groups (divides the minute into 10 to 60 second time slots)
- c. Carrier busy "listen-before-talk"
- d. Password security
- e. WWV time synchronization

Specifications (Cont.)

- **Data Acquisition**

1. **Remote Terminals**

- a. Individually addressable
- b. Polling can be enabled or disabled
- c. Polling interval in one minute increments
- d. Up to 24 status points
- e. Up to 24 analog-in points

2. **Telemetry (analog inputs)**

- a. Default values can be assigned in case of communication failures
- b. Scaling multipliers are used
- c. Offsets establish starting points
- d. High and low limits establish use of defaults

3. **Calculate**

- a. Analog values used to calculate demands
- b. Unlimited number of calculations available
- c. 30 different operators can be used

4. **Demands**

- a. Names
- b. Unlimited number
- c. Combines analog inputs in any manner
- d. Demand interval set from 1 to 60 minutes

5. **Setpoints**

- a. User designated initiation factors (kW, kVAR, kVA, temperature, etc.)
- b. User sets shed and restore values
- c. User decides the relationship of the shed and restore values

6. **Control Points**

- a. Name
- b. Up to 24 contacts-out (external)
- c. Unlimited number of internal control points

- **Reporting**

1. **Printer**

- a. Automatic printing of events (alarms and actions)
- b. Automatic printout of special screens at designated times

2. **Display building program**

- a. Used to develop special, custom-built screens

3. **Historical Data Files**

- a. Name
- b. Captures designated display numbers
- c. Establish interval between captures
- d. Establish file sizes
- e. Reset data by day of the month

4. **Graphics**

- a. Explanatory including lines and boxes
- b. Real time bar and line graphs
- c. User choice of colors, intensity, axes and offsets

5. **Transmitter Check-Back**

- a. Error indications from the transmitter sites can alarm at the LMC

- **Miscellaneous**

1. Pop-up bar type menus
2. On-screen programmable helps (lists options at each choice)
3. Programming is done by filling in the blanks
4. Function keys (F1 - F12) are user programmed to enact control or call up screens
5. A majority of programming characteristics can be changed while the program is running
6. Copy configurations to floppy disk
7. Automatic testing for illegal parameters and relationships
8. Redundant hardware configuration allows automatic transfer between machines in case of failure

- **Options**

- Communications package to allow a remote computer to query, modify the program, or enact control

RTC-1032 Remote Transmitter Controller

- Input - 120V ac, 60 Hz
- Power Consumption - 30 watts
- Operating temperature 0°C - +50°C
- Control Output - 6 SPST contacts, 250V ac, 3A
- Communications Modem - 1200 baud, bell 212
- Listen-before-talk - contact closure from carrier operated relay in the transmitter with LBT override (if the channel stays busy)
- Status Input - two contact closures

Model LMC-1041+ Load Management Controller

Typical Load Management Program

Control: Can be enabled or disabled from this page.

Mode: Allows automatic or manual operation.

Status: Shows whether control is active or inactive.

Status: Indicates current load control activity (shedding or restoring).

A: The demand level at which load control is initiated.

B: The demand level at which the program starts restoring the loads.

This screen was "built" by the user from standard information to display the most important information on a real-time basis.

Steps: Define the order of the procedure for controlling load.

Names: The type of load controlled in each step.

Time of Day: Shows which days and what time of day this strategy can be active (subject to other setpoint demands and/or contact closures).

Main Menu: This can be displayed on any page in the run mode by hitting the (ESC) key.

Step: Describes in which step this switch group is currently being used.

Current: Total system demand.

High: The high demand (with time) for the current period.

Low: The low demand for the current period.

Duration: The maximum and current duration of this step being active.

Load Shed-Min and Max: Sets the limits of load shed percentage for this step.

11:15:00 Feb 8

SAMPLE STRATEGY

Control	Enabled	Mode	Status	Step	Name	Ctrl	Mode	Setpoint	Target	Actual	Max	Min	Duration	Current
1	Water Heaters	En	Auto	1	A	1	1	1	1	1	1	1	1	1
2	Air Conditioners	Dis	Auto	2	B	1	1	1	1	1	1	1	1	1
3	Water Heaters	Dis	Auto	3	C	1	1	1	1	1	1	1	1	1

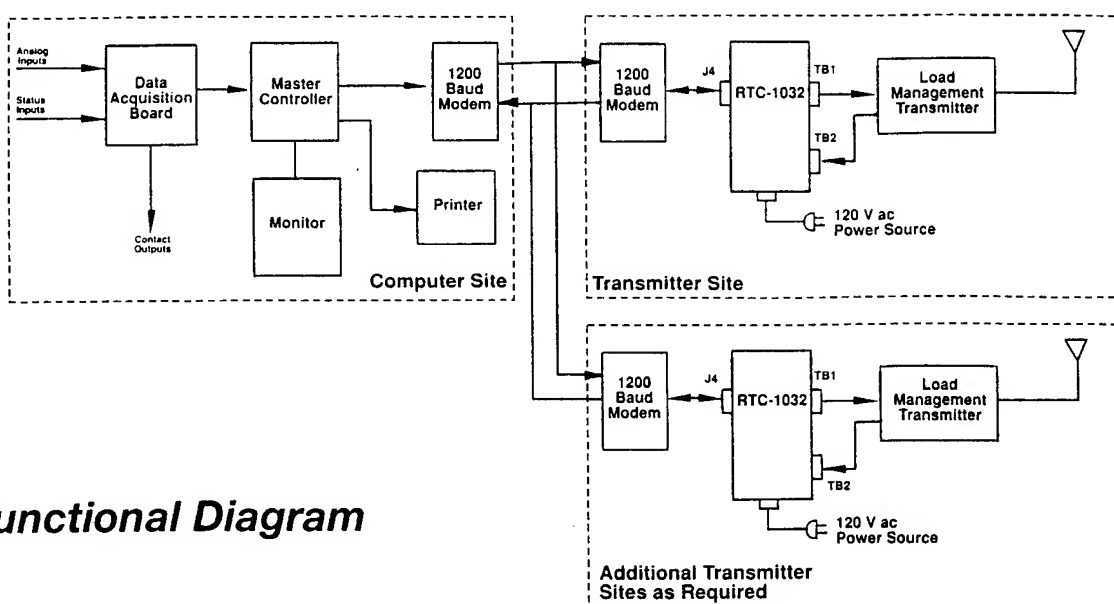
Switch Groups

Step	Ctrl	Stat	Step	Target	Actual	Max	Min	Duration	Current
1	Water Heaters	En	A	1	1	1	1	1	1
2	Air Conditioners	En	1	0	0	0	0	0	0

Time of Day

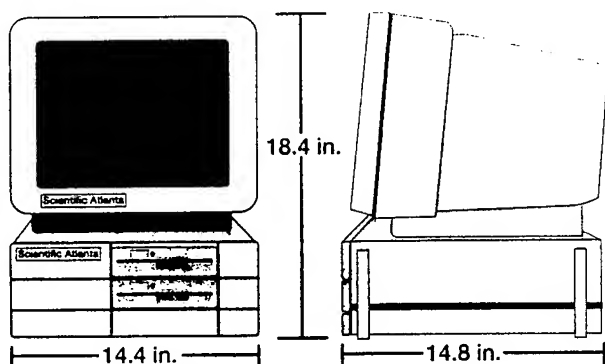
Status	En	1:00	6:00	1:00	6:00	1:00	6:00	1:00	6:00	1:00	6:00
Monday											
Tuesday											
Wednesday											
Thursday											
Friday											
Saturday											
Sunday											

Display Control Exit Editor

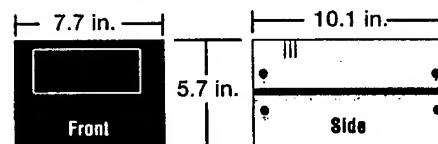


Functional Diagram

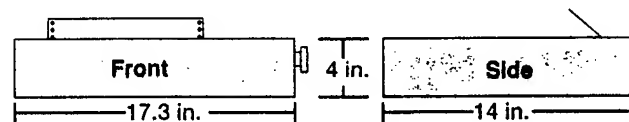
Component Outline Dimensions



Master Station



Remote Transmitter Controller



Printer

Scientific-Atlanta, Inc.

"Our Customers are the winners."

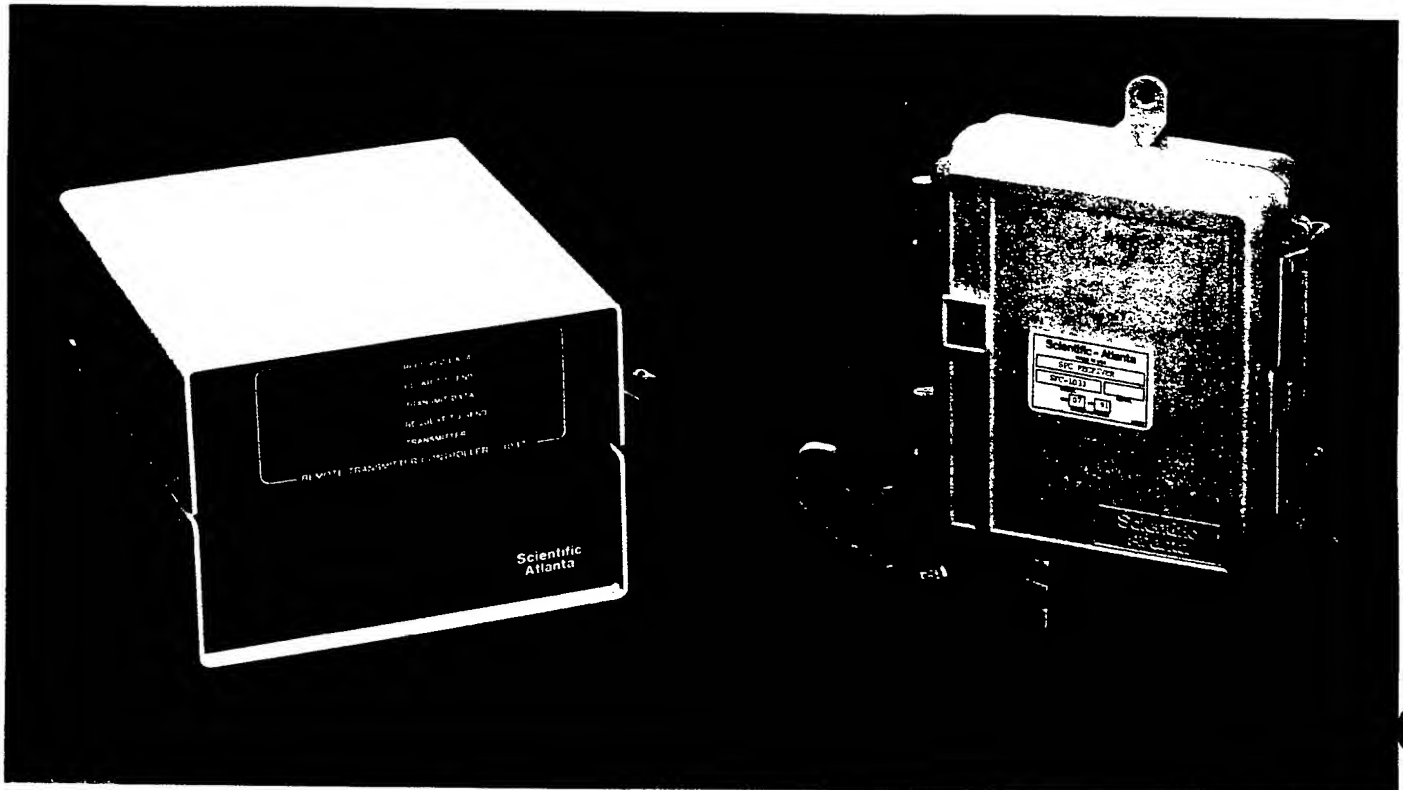
404-449-2900

United States: 4300 Northeast Expressway, Atlanta, GA 30340; FAX 404-449-2931; Telex 0542898
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**Scientific
Atlanta**

Instrumentation Group

Transmitter Controllers
Model **RTC-1032/SFC-1033**



20118

Generates audio messages received from a master controller to activate load management switches for demand control.

Features

- Multiple transmitter control (up to six)
- Capable of seven different VHF message formats
- "Listen-before-talk" option
- Watchdog circuitry
- Power fail detect circuit

Applications

The RTC-1032 Remote Transmitter Controller is capable of generating messages in any of seven code formats to activate load management switches based on data downloaded from a master controller.

The SFC-1033 Store and Forward Controller is identical to the RTC-1032 and is located adjacent to a repeater. The SFC repeats data it has received via the antenna switch relay circuit located in the repeater.

Scientific-Atlanta, Inc.

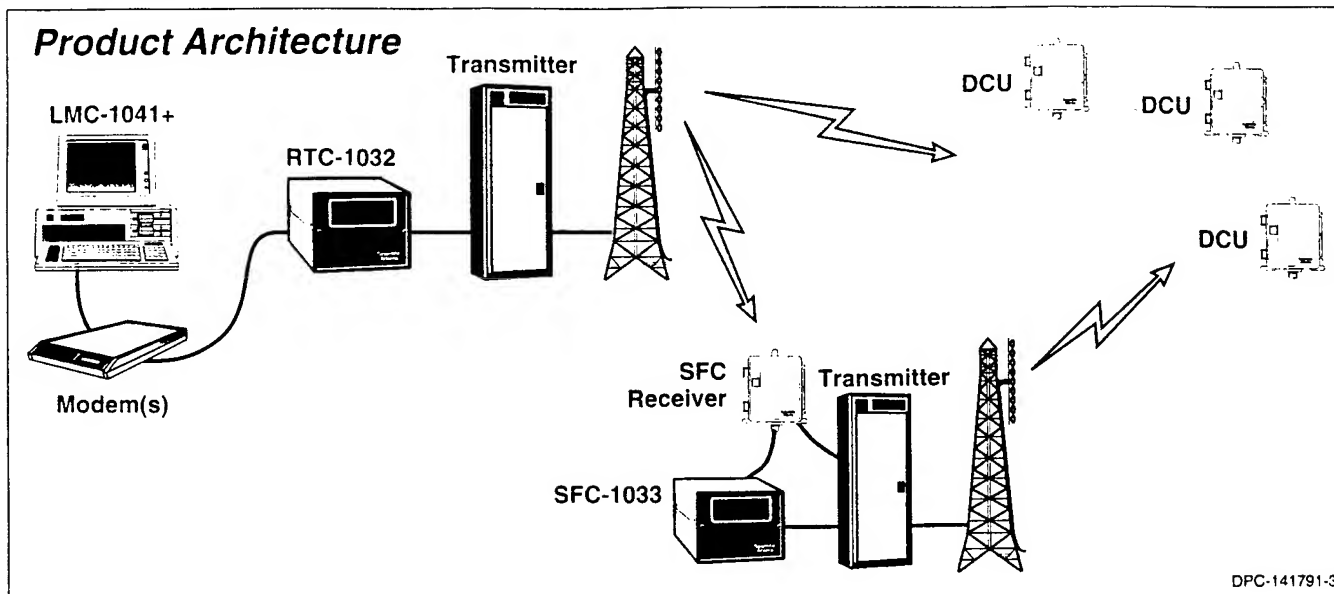
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C-16.14

Transmitter Controllers

Model *RTC-1032/SFC-1033*

Product Architecture



DPC-141791-3

Operation

The RTC-1032 receives load control messages and timing messages from a master controller. The RTC-1032 then generates audio tones representing digital messages and keys the transmitter at the appropriate times. The RTC-1032 is capable of receiving and responding to a contact closure for "listen-before-talk" to make sure the channel is free before transmitting. The RTC-1032 contains watchdog circuitry to eliminate lockups of microprocessors caused by transients and power surges.

Two modes of transmissions are provided when using multiple transmitter control. The "slotted mode" divides the minute into as many as six time slots, so that each RTC-1032 keys each transmitter at the appropriate interval. Where a single RTC-1032 is connected to multiple transmitters, the "contiguous mode" keys the transmitters back-to-back with only key up/key down delays between transmissions.

The SFC-1033 receives load control messages and timing messages via the antenna switch relay circuit located in the repeater. The SFC-1033 buffers the data and retransmits it, acting just like the RTC-1032. The SFC-1033 will generate the digital messages and key the transmitter/repeater at the appropriate times. The SFC-1033 can respond to a contact closure for "listen-before-talk" to make sure the channel is clear before transmitting. The SFC-1033 also contains the watchdog circuitry.

The SFC-1033 can control multiple transmitters located at a central remote location by tying into just one of the

receivers. Several SFC-1033s can be used within a system but one RTC-1032 is required at the main transmitter.

The RTC/SFC can generate the following formats:

Single-tone	Two tone sequential
SA Digital	Golay 23.12d
REMS 100/102	SA-105
SA-205	

Specifications

Enclosure

Aluminum

Size

7.7 in. W x 5.7 in. H x 9.1 in. D

Weight

8.5 lbs.

Shipping weight

10 lbs

Input voltage

120V ac, $\pm 10\%$, 60 Hz

Power consumption

30W max

Operating temperature

0°C to 50°C, non-condensing

Transmittal keying control

6 "SPST" - Normally opened relays rated at

.5A 125V ac

.6A 110V dc

Specifications subject to change without notice

Ordering Information

RTC-1032
SFC-1033

Remote Transmitter Controller
Store and Forward Controller

Scientific-Atlanta, Inc.

Our customers are the winners.

4300 Northeast Expressway, Atlanta, GA 30340 Tel: 404-449-2900 Fax: 404-449-2931
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C-16.15



The radio controlled switch interrupts loads, such as air conditioners, water heaters and irrigation pumps, upon command from the utility's master controller for load management.

Features

- 4 million individual fixed addresses
- 6 programmable operational addresses per switch can be grouped for divisional, area, substation or feeder control
- Remote programming via radio message
- Choose from 4,096 programmable, operational addresses
- Distributed intelligence design provides up to 8 hours of control with one message
- Randomized "shed" and "restore" provide smooth, graceful ramping in and out of load control
- High performance dual conversion FM receiver
- Cold load pickup and cancel
- A record of actions kept in non-volatile memory, accessible by the Portable Counter Display®
- Fail safe timer reconnects load at the end of the control period
- Weatherproof, Lexan® enclosure
- Electronics mounted in removable door for easy field maintenance
- One, two, three or four separate functions

Description

The SA-205 format Digital Control Unit (DCU) is a radio controlled switch designed to switch remote loads on and off in response to commands from a central control. Additionally, each digital control unit may be individually programmed and controlled remotely via radio signals.

Utilizing "distributed intelligence", control for up to eight hours can be accomplished upon the receipt of a single radio command. A smooth transition into as well as out of control is ensured through the use of a unique, linear control algorithm in which each switch independently selects its own start and stop times after receipt of a radio control message.

SA-205 Digital Control Units are available in one, two, three or four function designs. Cold load pickup, a feature which disconnects load when power is restored after an outage, is remotely programmable from 0 to 60 minutes via radio message.

Important data about the DCU's operation, including the number of operations, time since its memory was reset and configuration data, is maintained in the unit's memory. Data can be read with a Scientific-Atlanta Portable Counter Display (PCD), without opening the DCU door. The Portable Counter Display transmits a radio signal to the digital control unit which causes the DCU to flash its LEDs in a digital manner. The PCD optically reads the data and displays it on a liquid crystal display.

Scientific Atlanta

Instrumentation Group

Portable Test Unit Model **PTU-1084/1085**

A hand-held device that locally exercises the functionality of a Digital Control Unit.



19921

Features

- Provides on-site testing of radio controlled switches
- Available for use with popular FSK and AFSK code formats
- Powered by replaceable 9V battery
- Low battery indicator
- Includes nylon case

Application

Scientific-Atlanta's PTU-1084/1085 Portable Test Unit is a hand-held, battery operated low output transmitter which permits field testing of Digital Control Units. It allows manual transmission of digital radio signals to test for proper operation of a switch. The economy and portability of the PTU make it practical for each switch to be tested as it is installed.

The PTU-1084/1085 is crystal-controlled and transmits on a customer-specified VHF frequency, between 138 and 174 MHz.

Scientific-Atlanta, Inc.
404-449-2900

C-16.17

GAS AIR CONDITIONING EQUIPMENT

January 14, 1992

ENGINE DRIVEN:

TECOCHILL: 125, 150tons (165tons w/economizer); Teco Drive 454; screw compressor
R22 refrigerant; heat recovery available
(250 and 500 ton models in field test)
Mingledorff's: Bruce Longino, 404-446-6311

TRANE: 55, 80 tons; Hercules engine; Trane reciprocating compressor
Trane: Jim Gieselman, 404-321-7500

THERMO KING: 15ton, 25ton(Summer 1991); rooftop units; Hercules engine;
Thermo King reciprocating compressor; +80% furnace included
Split 15ton system available summer 1991
Thermo King Atlanta, Inc.: Harold Haskell, 404-361-4019

ALTURDYNE ENERGY SYSTEMS: 26, 47, 75, 94, 114, 141, 186, 231, 284tons;
Reciprocating compressors, industrial grade engines, analogue controls
Associated Air Systems, Inc.: Al Schnur, 404-587-0970

CUSTOM BUILT:

Owsley Brothers: Bob Reid, 404-361-1100
650ton; Waukesha engine; York centrifugal compressor;
Heat recovery available

Utility Systems Corp.: Richard Nelson, 516-287-3741
250, 400, 550, 665, 800ton; Caterpillar engines, York screw comp.
Heat recovery available

DIRECT FIRED 2-STAGE ABSORPTION: *No CFC's !*

CARRIER: 100 - 500tons; operates w/59F condenser water
Carrier: Shawn Wood, 404-988-0893

McQuay-Sanyo: 20 - 1,500tons; simultaneous heating/cooling optional
Brake & Hegyan (Atlanta): Michael Lawler, 404-455-1954

TRANE: 100,120,150,180,200,240,300,350,400,450,500, up to 1100tons
Units 550tons and smaller can be built for outside installation
Trane: Jim Gieselman, 404-321-7500

YORK: 100,125,140,150,170,200,250,270,320,345,400,430,500 up to 1,500tons-
Manufactured by Hitachi; will manufacture in USA
York Int'l.: Clint Knudson, 404-925-1002

YAZAKI: 20,30,40,50,60,80,100tons
Atlanta Gas Light Co.: Jim Sullivan, 404-584-3758

STEAM FIRED ABSORPTION: *No CFC's !*

Two Stage:

CARRIER: 150,250,400,500,600,700,800,1000,1200,1500tons

TRANE: 385-1060tons

Input of 12.2lbs/ton-hr, 123psig steam for rated full load

YORK: 250,270,310,360,400,450,500, up to 1,500tons

Input of 9.9lbs/ton-hr, 114psig steam for rated full load

MCQUAY-SANYO: 100-1500tons

Single Stage:

CARRIER: 70-815tons

Input of 18lbs/ton-hr, 14psig steam for rated full load

TRANE: 101-1,660tons

Input of 18.7lbs/ton-hr, 14psig steam for rated full load

YORK: 120 to 1,400tons

Input of 18.3lbs/ton-hr, 15psig steam for rated full load

HEAT RECOVERY ABSORPTION: *No CFC's !*

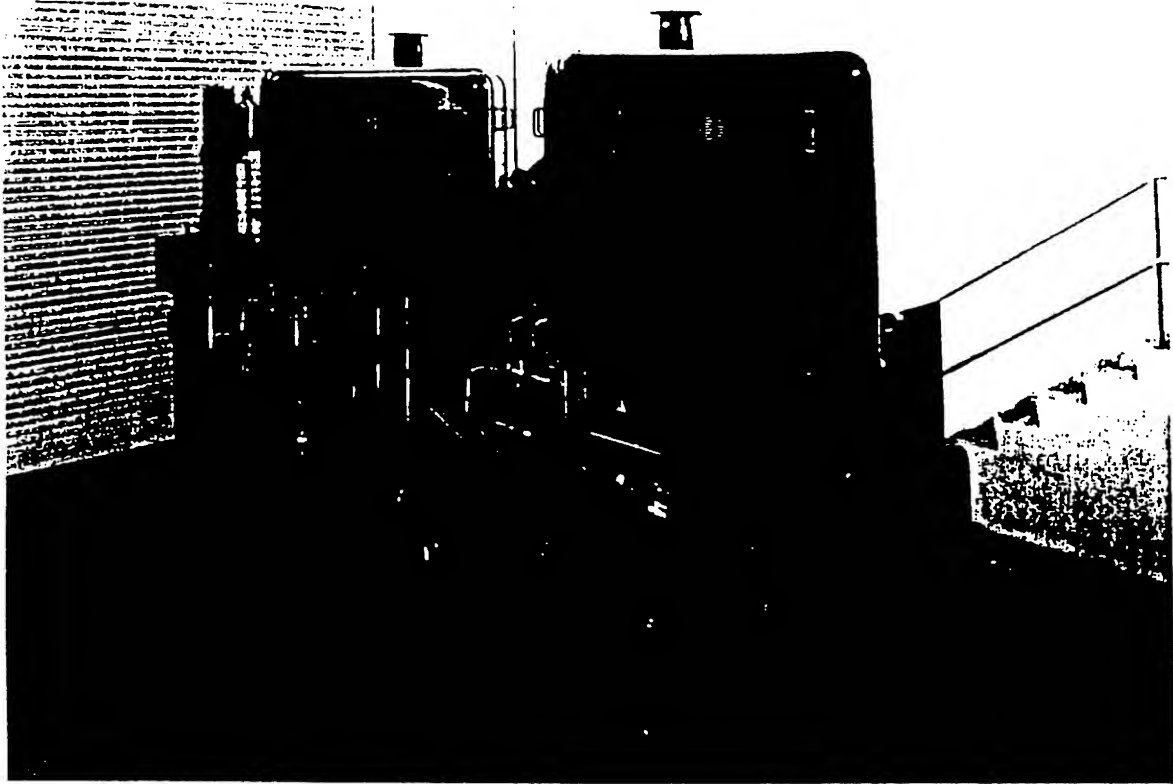
YORK: 100,125,140,150,170,200,250,320,345,400,450,500, up to 1,500tons

Uses clean exhaust gas 550-1500F

Option to use engine jacket water heat recovery

TECOCHILL

Gas Engine Driven Chiller Systems



Centrifugal Compressor Line

- 30 to 95% Energy Savings
- Fully Automatic Unattended Operation
- Continuous 20 to 100% Modulation
- Open Drive Compressor
- Hot Water Available
- Remote Diagnostics
- Made in U.S.A.

TECOCHILL centrifugal chillers provide cost effective and reliable chilled water for commercial, industrial and institutional cooling needs. The chillers combine the familiarity of vapor compression refrigeration with the energy efficiency of TecoDrive, a natural gas prime mover. TECOCHILL chillers provide substantial savings over electric and absorption chillers by reducing energy costs 30 to 95%. These savings are due to an exceptionally efficient design, lower utility costs and avoided electric demand charges.

The TECOCHILL CH-500 chiller uses two TecoDrive engines directly coupled to open-drive centrifugal compressors. The TECOCHILL CH-250 chiller uses a single TecoDrive engine. TecoDrive engines have earned a strong reputation for reliability and performance in the HVAC community. This reputation has resulted from millions of hours of operation in chillers and cogeneration modules.

TECOCHILL chillers provide the highest coefficient of performance (COP) of any type of gas chiller. The inherent variable speed capability of the TecoDrive engine and compressor team offers even higher part-load system efficiencies and superior load following capability. Continuous modulation from 20 to 100% provides customers with precisely controlled chilled water temperature.

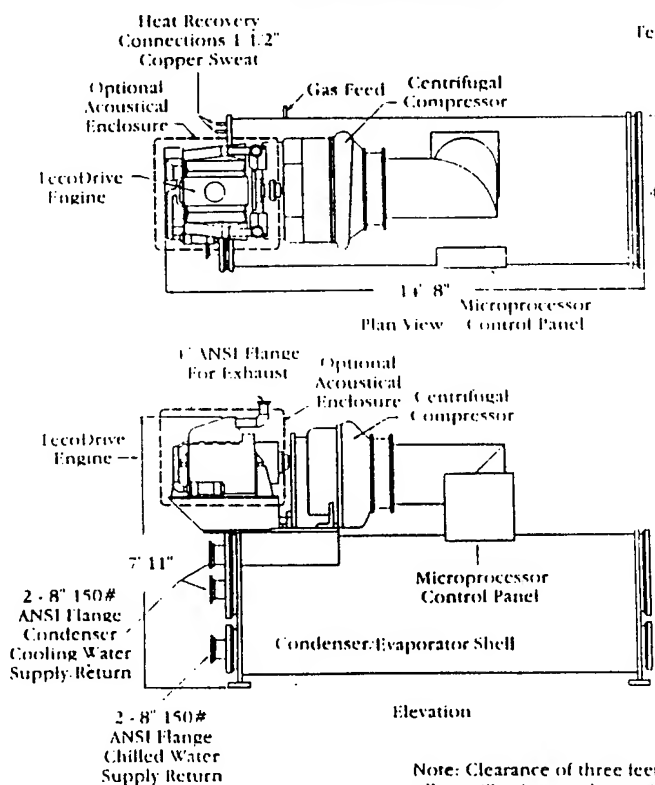
A powerful microprocessor based control system provides fully automatic operation, continuous chiller monitoring, digital display, fault and safety diagnostics and convenient interface to energy management systems in a user-friendly package. These features have resulted in a significant reduction in service costs.

Optional equipment includes a heat recovery package that yields as much as 1,700,000 Btu/hr of hot water which can supplement boilers or other thermal needs. Acoustical enclosures are available that reduce noise level. A remote monitoring and control system is available that permits remote operation and diagnostics via telephone and personal computer.

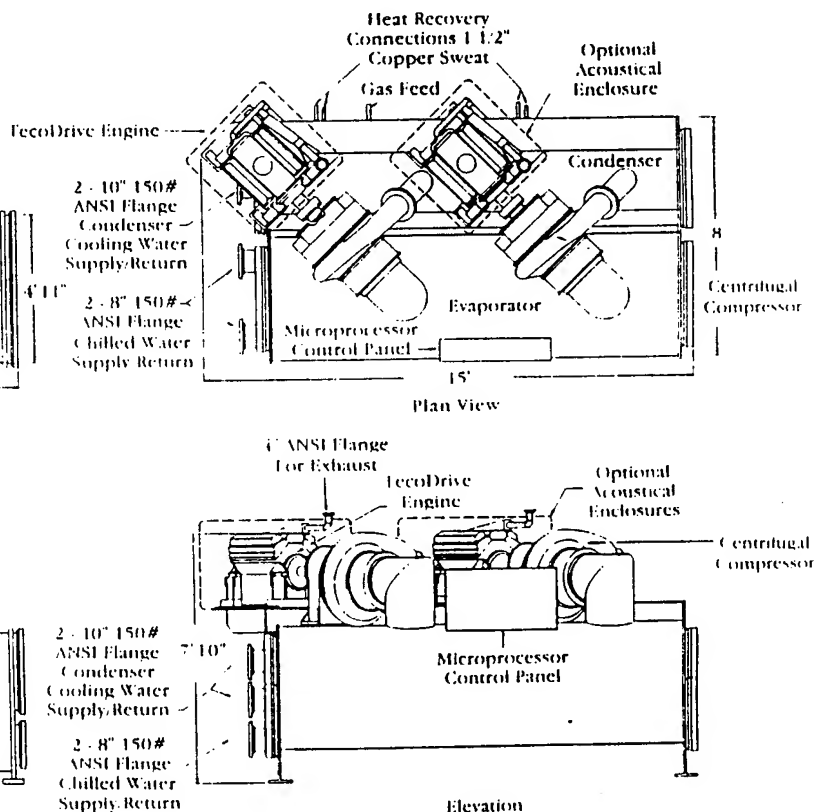
Made in the USA, TECOCHILL chillers are readily available and serviced by factory-trained local HVAC service professionals. TECOCHILL chillers are equal in size to electric chillers and smaller than absorption chillers. Also, open-drive compressors allow easier conversion to alternate refrigerants in the future. The chiller has been designed for ease of installation and with standard connections.

A cooling system evaluation is no longer complete without a TECOCHILL comparison. For further information, please contact Tecogen Inc. directly or our local sales representative.

TECOCHILL CH-250



TECOCHILL CH-500



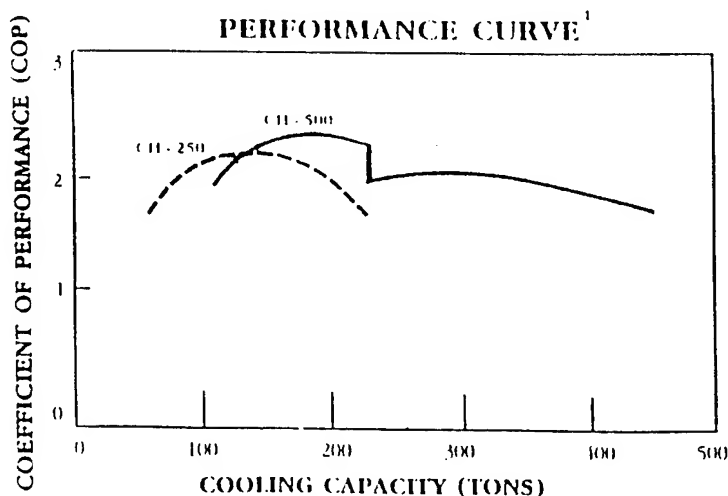
Note: Clearance of three feet required on all sides. Scale: 3/16" = 1 ft.
All specifications and materials subject to change without notice.
All specifications and ratings are +5%

GENERAL SPECIFICATIONS

Model	CH - 250	CH - 500
Capacity (Tons) ¹	230 220	460 430
COP		
Full load	1.7	1.7
Integrated Part Load Value (IPLV)	2.0	2.0
RPM Full Load	3000	3000
Gas Input (SCFH) ² @ 6 - 28 in. H ₂ O	1750	3500
Recoverable Heat at Full Load (BTU/H) ³	850,000	1,700,000
Acoustic Level (dBA) @ 20 ft. with Optional Enclosure	82	85
Electric Power Requirements	208 VAC Three phase, 35 Amps Service, 4 kW	208 VAC Three phase, 50 Amps Service, 7 kW
Chilled Water Flow (GPM)	600	1200
Cooling Tower Requirements		
Condenser Flow Rate (GPM)	750	1500
Pressure Drop (ft. H ₂ O)	11	11
Temperatures, without Exhaust Heat Exchangers (°F) ³	85.0 - 95.0	85.0 - 95.0
Temperatures, with Exhaust Heat Exchangers (°F) ³	85.0 - 96.3	85.0 - 96.3
Exhaust		
Without Exhaust Heat Exchangers ³	4 in. ANSI Flange, 300 SCFM, 26 in. of water max. back pressure, 1200°F max. temperature	(Same per engine)
With Exhaust Heat Exchangers ³	4 in. ANSI Flange, 300 SCFM, 16 in. of water max. back pressure, 300°F max. temperature	(Same per engine)
Refrigerant	R-11 (1,010 lbs.)	R-11 (1,770 lbs.)
TecoDrive TM Engines	One	Two
Rigging Weight (lbs.)	18,000	26,000
Dimensions	14'8" long x 4'11" wide x 7'11" high	15' long x 8' wide x 7'10" high

Note 1: Per ARI 550 - 89 Method
Note 2: H1V 1020 BTU/SCF

Note 3: 60% of heat from engine jacket, exhaust manifold
and oil cooler, 40% from engine exhaust heat exchanger



All specifications and materials subject to change without notice.
All specifications and ratings are +5%.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #310

ECO: 16, INVESTIGATE POST DEMAND

DATE: 22-Apr-92

FILE: DEMAND.WK

PREPARED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY:

CLIENT PROJECT ENG: TERRY SEABROOK

[illegible]

[illegible]

[illegible]

[illegible]

JOB Fort McPherson/Fort Gillem ESOS Study

SHEET NO EMC #3105-000

OF _____

CALCULATED BY CEL

DATE _____

CHECKED BY _____

DATE _____

SCALE _____

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

1) RADIO CONTROL FAMILY HOUSING AC UNITS

- 108 AC units
- 751 KW load
- Estimate off for 7 minutes every 30 minutes, $(7/30) = .23$ load shed.
- 751 KW * .23 = 175 KW
- Cost \$73,527
- Cost per KW, $\$73,527/175 \text{ KW} = \420

2) THERMAL STORAGE, BLDG. 200

- 750 ton load, est 487 KW
- With pumps, tower, etc. 673 KW
- Cost \$1,044,893
- Cost per KW, $\$1,044,893/673 = \155

3) GAS DRIVEN CHILLER

- 460 ton load, est 300 KW
- Cost \$400,230
- Cost per KW, $\$400,230/300 = \134

4) LIGHTING CONTROL

- Control 310 watts of light
(2, 4'x 2', 4 tube fluorescent)
- 1 wall switch, \$65.11
- Cost per KW, $\$65.11/.31 = \210

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB Fort McPherson/Fort Gillem ESOS Study

SHEET NO EMC #3105-000

OF _____

CALCULATED BY CEL

DATE _____

CHECKED BY _____

DATE _____

SCALE _____

5) PEAK SHAVING GENERATOR

- 500 KW generator
- Est. cost \$130,190
- Cost per KW, $\$130,190/500 = \260

6) HIGH EFFICIENCY MOTOR

- 5 hp high efficiency replacement
- .81 KW savings
- Cost \$488
- Cost per KW, $\$488/.81 = \602

7) EXIT SIGN REPLACEMENT

- Replace bulbs in 10 fixtures
- .3 KW saved
- \$380 construction cost
- Cost per KW, $380/.3 = \$1267$

APPENDIX C-17

EVALUATE BOILER OPERATION

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: EVALUATE BOILER OPERATION

EMC PROJECT: #3105.000
DATE: 07/20/92
FILE: BOILER.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY COST		DISCOUNT FACTOR	SAVINGS FACTOR	
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG	MBtu/ft2	
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	11.11 UPWE	kWh/ft2	
ELECTRIC DEMAND CHARGE	\$106.20 kW	10.59 UPW	kW/ft2	
ECONOMIC LIFE 15 YRS				

BUILDING NUMBER	EXISTING UA VALUE (BTUxHR/F)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
207	82,888	0	0	2,588	2,588	12,086	0	0	12,086			
505	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
506	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
507	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
508	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
509	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
510	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
511	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
512	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
513	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
514	61,791	0	0	1,929	1,929	9,008	0	0	9,008			
TOTAL	700,798	0	0	21,878	21,878	102,166	0	0	102,166			

APPENDIX C-18
EXIT SIGN RETROFIT

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-18 EXIT SIGN RETROFIT

ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	20634.
B. SIOH	\$	1135.
C. DESIGN COST	\$	1238.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	23007.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	487.	\$ 3639.	15.61	56803.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		487.	\$ 3639.		\$ 56803.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	32.
(1) DISCOUNT FACTOR (TABLE A)	14.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	465.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	465.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	18745.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS \text{ ECONOMIC LIFE}))$ \$ 3671.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 57268.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.49
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.27

**REPLACE EXIT SIGN BULBS SAMPLE CALCULATION, ECO #18
BUILDING 41**

Given:

# of Exit Signs	= 4 signs	- from field survey
Existing Bulb Wattage	= 40 Watts	- from field survey
Improved Bulb Wattage	= 10 Watts	- from manufacturer's data
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Energy Usage:

$$(4 \text{ signs}) * (40 \text{ Watts / sign}) = 160 \text{ Watts}$$
$$(0.16 \text{ kW}) * (8,760 \text{ hrs / yr}) = 1,402 \text{ kWh}$$

Improved Energy Usage:

$$(4 \text{ signs}) * (10 \text{ Watts / sign}) = 40 \text{ Watts}$$
$$(0.04 \text{ kW}) * (8,760 \text{ hrs / yr}) = 350 \text{ kWh}$$

Peak Demand Savings:

$$(0.16 - 0.04 \text{ kW}) = 0.12 \text{ kW}$$

Annual Energy Savings:

- Electric:	(1,402 - 350 kWh)	= 1,052 kWh
- Gas:		= 0 MBtu

Annual Energy Cost Savings:

$$(0 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (1,052 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.12 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$39 / \text{yr}$$

Annual Increased recurring cost

$$(\$7.95) - (2 * \$2.25) * (8,769 \text{ yr} / 10,000 \text{ hr}) = \$3.02 / \text{yr} / \text{fixture}$$
$$4 \text{ fixtures} = 4 * \$3.02 = \$12.08 / \text{yr}$$

Estimated Construction Cost:

$$\$38.00 / \text{sign} - \text{from engineer's cost estimate}$$

$$(\$38.00 / \text{sign}) * (4 \text{ sign}) = \$152$$

$$\$152 + (\$152 * .055 \text{ SIOH}) + (\$152 * .06 \text{ DESIGN}) = \$169$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: REPLACE EXIT SIGN LIGHTING WITH FLUORESCENT LIGHT RETROFIT KIT

EMC PROJECT: #3105.000

DATE: 07/20/92

FILE: GEXITLIT.WK3

PREPARED BY: CAMERAN DIBAI

CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY COST		DISCOUNT FACTOR	
INCREMENTAL GAS COST		\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST		\$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE		\$102.66 kW	14.53 UPW

25 YRS

ECONOMIC LIFE

ESTIMATED 8760 HOURS OF EXIT LIGHTING PER YEAR

BLDG	NUMBER OF FIXTURES	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENERG SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
G101	70	2.1	18,396	0	63	\$471	\$216	(\$211.40)	\$475	\$2,966	2.5	6.2
103	9	0.27	2,365	0	8	\$61	\$28	(\$27.18)	\$61	\$381	2.5	6.2
207	48	1.44	12,614	0	43	\$323	\$148	(\$144.96)	\$326	\$2,034	2.5	6.2
213	40	1.2	10,512	0	36	\$269	\$123	(\$120.80)	\$271	\$1,695	2.5	6.2
G400	48	1.44	12,614	0	43	\$323	\$148	(\$144.96)	\$326	\$2,034	2.5	6.2
G401	20	0.6	5,256	0	18	\$135	\$62	(\$60.40)	\$136	\$847	2.5	6.2
505	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
506	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
507	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
508	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
509	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
510	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
511	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
512	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
513	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
514	30	0.9	7,884	0	27	\$202	\$92	(\$90.60)	\$204	\$1,271	2.5	6.2
935	8	0.24	2,102	0	7	\$54	\$25	(\$24.16)	\$54	\$339	2.5	6.2
TOTAL	543	16.29	142,700	0	487	\$3,653	\$1,672	(\$1,639.86)	\$3,686	\$23,007	2.5	6.2

DA FORM 5418-R, APR 85

APPENDIX C-19
LIGHTING UPGRADES

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-19 LIGHT RETROFIT

ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 2135242.
B. SIOH	\$ 117439.
C. DESIGN COST	\$ 128115.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 2380796.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	10143.	\$ 75781.	15.61	1182934.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		10143.	\$ 75781.		\$ 1182934.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$ 130378.
(1) DISCOUNT FACTOR (TABLE A)	14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$ 1894392.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$ 1894392.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 390368.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .66

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 206159.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 3077327.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.29

(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.55

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 19 - PNL Lights

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-19.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
Office	483	1,130,220	0	3,854	\$28,821	\$49,585	\$0	\$78,405	\$854,105	1.4	10.9
Warehouse	787	1,841,580	0	6,280	\$46,960	\$80,793	\$0	\$127,754	\$1,526,690	1.2	12.0
TOTAL	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 19 - PNL Lights

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

Operation: 2340 hrs / yr

EMC PROJECT: #3105.000
DATE: 2-APR-92
FILE: ECO-19.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

Bldg. Type	Exist Demand (kW)	Imprvd Demand (kW)	Cooling Demand Savings (kW)	Demand Savings (kW)	Electric Usage Savings (kWh/yr)	Installation Cost (\$)
Warehouse	1,705	918	0	787	1,841,580	\$1,369,229
Office	1,201	718	0	483	1,130,220	\$766,014

TRI-SERVICE MILITARY CONSTRUCTION PROGRAM (MCP) INDEX

CALENDAR YEAR	*1990	*1991	1992	1993	1994	1995	1996
JANUARY	1676	1742	1810	1875	1938	1999	
FEBRUARY	1679	1746	1813	1878	1941	2002	
MARCH	1682	1750	1816	1881	1944	2005	
APRIL	1686	1753	1819	1885	1947	2009	
MAY	1693	1760	1826	1891	1953	2015	
JUNE	1700	1767	1833	1897	1959	2021	
JULY	1706	1773	1839	1904	1966	2027	
AUGUST	1713	1780	1846	1910	1972	2033	
SEPTEMBER	1720	1787	1853	1916	1978	2039	
OCTOBER	1726	1793	1859	1922	1984	2045	
NOVEMBER	1731	1799	1864	1927	1981		
DECEMBER	1736	1805	1869	1932	1990		

Example: (For 10 Month Construction Period)

Submittal Date	- 1 Sept. 90	1720	} -- 13 Months
Bid Opening Date	- 1 Apr. 91		
Contract Award Date	- 1 May 91		
Midpoint of Construction	- 1 Oct. 91	1793	

Cost Growth Factor = $1793 / 1720 = 1.0424$ Use 1.04

Use 4 % Per Fiscal Year For Projection Beyond FY 1997

* Historical

Cost Escalation

Report Date: 12/89 (use 1/90)

Present Date 4/92

MCP Index

1676

1819

Cost Growth Factor = $1819 / 1676 = 1.0853$ use 1.09

**FEASIBILITY STUDY FOR
LIGHTING SHARED ENERGY SAVINGS PROJECT
FORT McPHERSON AND FORT GILLEM, GEORGIA**

U.S. Army Corps of Engineers
Huntsville Division
Contract DACA87-89-D-0007
Delivery Order 0005

FINAL REPORT

July 20, 1990

The fixtures in the Generals' offices, Rooms 333, 336, and 339, should be changed to a 2 x 4 or a 2 x 2 louvered fixture the same style as Item 1. By installing fixtures as specified in Item 1, a maintained foot candle level of 60 FC will result, yielding a 78 percent reduction in wattage in comparison to the existing incandescent system estimated wattage of 7 kW. Installation costs are estimated at \$1,608. The fixtures can be connected to two fluorescent dimming circuits to provide full control of the lighting level. Simple payback based on energy savings will be 3 years. Increased maintenance savings not included will shorten payback period.

The basement level or any areas without any artificial lighting could have a minimum number of fixtures powered by a battery system or by the building UPS system to provide continuous lighting during generator startup, (limited to 10 seconds by life safety codes), thus eliminating the interruption of critical operations due to a utility failure.

Exit signs with incandescent lamps should be replaced or retrofitted with fluorescent lamps which will give a lighting wattage reduction of 80 percent from an estimated load of 3 kW, and an increase in light output of over 65 percent. The installation cost is estimated at \$2,220. The use of a Liquid Crystal Display (LCD) type is not recommended since LCD signs do not provide sufficient illumination to be visible during a fire emergency evacuation. Simple payback based on energy savings will be 1.5 years. Increased maintenance savings not included will shorten payback period.

3.7 CAPITAL COST ESTIMATE

3.7.1 Warehouse

The 11,100 existing fluorescent fixtures in use will be replaced with 4,964 High Pressure Sodium (HPS) fixtures at a cost of \$1,255,900 (in 12/89 dollars). This does not include \$273,000 for rewiring from 120 V to 277 V believed necessary for the warehouses because of the age and condition of the existing 120 V wiring. Because this rewiring should be done by the government anyway, we have assumed that it would be done by separate contract and should not be reflected in the SES analysis of potential costs and

benefits. Including the cost of rewiring will make it harder for the Third Party Contractor to meet his economic goals with the Shared Energy Savings Contract. However, the effect of rewiring on the gross payback will be included in Section 5. The unit cost of installing new HPS fixtures is \$253/fixture. This includes the cost of the luminaire and lamp, and the cost of labor at \$25/hr. The equipment cost is based on discussions with potential vendors.

The cost estimate is based on replacing the fixtures at Fort Gillem. Fort McPherson warehouses, although likely to be included in any retrofit program, contain only 5 percent of the total number of fixtures and was not included in the evaluation.

3.7.2 Office

The existing fluorescent fixtures will be replaced with parabolic louvered fixtures with energy-saving lamps and ballast arrangements. The cost will be \$1,294,120 for both Fort Gillem (\$702,765) and Fort McPherson (\$591,355 including \$244,483 for CCF), including the Command and Control Facility. Unlike the warehouses, no supply rewiring is required.

3.8 MAINTENANCE COST ESTIMATE

3.8.1 Warehouse

The cost of yearly maintenance for HPS fixtures is based on group relamping at 75 percent of the lamp life. The procedure is similar to that described in Section 3.4. Maintenance includes the material and labor necessary to replace and clean lamps and to replace ballasts. Material costs are based on discussions with vendors. The average annual cost of maintaining the fixtures is \$53,611.

SECTION 4

ENERGY COMPARISON

The lighting retrofit programs described in Section 3.5 for offices and warehouses offer significant energy savings. In the offices, switching to parabolic louvered fixtures and energy saving magnetic ballasts will result in the following:

	<u>Fort Gillem</u>	<u>Fort McPherson</u>	<u>Total</u>
Existing load (kW)	1,201	1,217	2,418
Future loads (kW)	<u>718</u>	<u>669</u>	<u>1,387</u>
Savings (kW)	483	548	1,031
Percent savings			43%

In the CCF alone, the load will be reduced from 507 kW to 255 kW, a reduction of 50 percent.

In Fort Gillem's warehouses, switching to High Pressure Sodium fixtures will reduce the lighting load from 1,705 kW to 918 kW, a reduction of 787 kW or 46 percent.

The savings are based on the energy reduction calculated by system characteristics (connected load and hours of operation) observed in the walkdown, compared to reduction in power of the recommended system.

The power cost savings will not be quite so high in percentage savings because of Georgia Power Company's declining block rate structure. The rates are as follows:

	<u>Incremental Usage (kWh)</u>	<u>Rate (\$/kWh)</u>
<u><300 hr/mo * Billing Demand:</u>	50,000	0.05710
(up to maximum of	150,000	0.05590
1,961,500 kWh)	800,000	0.04150
	961,400	0.03950
<u>>300 hr/mo * Billing Demand:</u>	Balance of kWh	0.01110

In addition, a fuel charge of \$0.016045 is charged for every kWh of usage.

The lighting systems are assumed to be in use 9 hours/day, 5 days/week or an average of 195 hours/month.

Table 4-1 presents the existing and future power charges for all of the offices including the Command and Control Facility and for the CCF separately. Note that the average rate increases with the modification because a greater percentage of the power usage is shifted to the higher rates. The total bill for all office lighting, however, is reduced by 45 percent and for the CCF alone, by 50 percent. In addition to the power savings due to lighting system changes in the CCF, there will be a net decrease in power consumed for air conditioning. The CCF is cooled by a motor-driven chiller. The differential energy consumption was determined by modeling the building and HVAC system both before and after the proposed modification. The total annual energy reduction, including the effects on heating, is 184,552 kWh/yr. The HVAC load reduction of other buildings was not calculated because due to system sizes and usage patterns the energy reduction will be small compared to lighting energy reduction.

The energy cost savings may be overstated due to electric loads other than lighting. These additional loads will generally be unaffected by the proposed lighting system changes and therefore, reductions in lighting system loads may occur in lower rate blocks. The approach used is more optimistic for the value of savings.

The warehouse power charges are presented on Table 4-2. The average rate will increase from \$0.066/kWh to \$0.072 kWh, but the total bill will be reduced by 41 percent.

TABLE 4-1

OFFICE (ALL) POWER COST

Monthly Energy Rate which Includes Demand			Existing System		Modified System	
Hr/Mo	Incr. kWh	Rate	Avg. 471,534 kWh/Mo kWh	Cost	Avg. 270,314 kWh/Mo kWh	Cost
<300	50,000	\$0.0571	50,000	\$ 2,855	50,000	\$ 2,855
	150,000	0.0559	150,000	8,385	150,000	8,385
	800,000	0.0415	271,534	11,269	70,314	2,918
	961,000	0.0395	0	0	0	0
>300	(Balance)	0.0111	0	0	0	0
Fuel	All kWh	0.016045	471,534	7,566	270,314	\$ 4,337
				\$30,074		\$18,495
			Avg. Rate	\$0.064/kWh		\$0.068/kWh

COMMAND AND CONTROL FACILITY POWER COST

Existing System				Modified System		
	kWh	@ Avg. rate from above	Cost	kWh	@ Avg. rate from above	Cost
Lighting Costs:	98,865	\$0.064/kWh	\$6,327	49,725	\$0.068/kWh	\$3,381
Differential						
Air Cond. Costs:	Base		base -15,379 \$6,327	0.068		-1,046 \$2,335

A/C Demand Savings = $15,379 \text{ kWh} / (195 \text{ hrs/mo}) = \boxed{79} \text{ kW}$

APPENDIX C-20

COMPUTER SIMULATION SUMMARIES

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: Computer Simulation Summary

EMC PROJECT: #3105.000
DATE: 13-APR-92
FILE: G101ECO.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

Bldg: G101 Area: 120,182 ft²

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (kWh/yr)	Lighting Electric Use (kWh/yr)	Recept. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (Mbtu/yr)
Baseline	523,833	8,551	299,666	416,645	236,958	729,764	439,234	2,130,817	670	524	7,794
ECO#1 - Wall Savings/(Loss)	305,157	6,736	283,434	416,645	236,958	729,764	439,234	2,112,770	651	305	7,514
	218,676	1,815	16,232	0	0	0	0	18,047	19	219	280
ECO#2 Savings/(Loss)	401,179	6,910	297,925	416,645	236,958	729,764	439,234	2,127,435	661	401	7,660
	122,653	1,641	1,741	0	0	0	0	3,382	9	123	134
ECO#3 Savings/(Loss)	505,158	8,356	299,243	416,645	236,958	729,764	439,234	2,130,199	668	505	7,773
	18,675	196	423	0	0	0	0	618	2	19	21
ECO#6 Savings/(Loss)	523,833	8,551	297,878	416,645	236,958	729,764	439,234	2,129,030	670	524	7,788
	0	0	1,788	0	0	0	0	1,788	0	0	6
ECO#7 Savings/(Loss)	290,370	2,538	277,213	416,645	140,860	729,764	439,234	2,006,253	670	290	7,136
	233,463	6,013	22,453	0	96,098	0	0	124,564	0	233	658
ECO#12 Savings/(Loss)	221,515	2,047	192,948	349,638	132,000	729,764	439,234	1,845,631	613	222	6,519
	302,318	6,504	106,718	67,007	104,958	0	0	285,187	57	302	1,275
ECO#13 Savings/(Loss)	523,833	8,551	312,788	416,645	236,958	729,764	439,234	2,143,939	544	524	7,839
	0	0	(13,122)	0	0	0	0	(13,122)	126	0	(45)
ECO#15 Savings/(Loss)	565,330	9,020	281,067	416,645	236,958	613,004	439,234	1,995,929	670	565	7,375
	(41,498)	(469)	18,598	0	0	116,760	0	134,889	0	(41)	419

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT McPHERSON
 ECO: Computer Simulation Summary

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105,000
 DATE: 07/20/92
 FILE: G207ECO
 PREPARED BY: DENNIS JONES
 CHECKED BY:

Bldg: G207

Area: 149,300 ft ~ 2

Run Description	Heating Gas Use (kBtu/yr)	Heating Electric Use (kWh/yr)	Cooling Electric Use (kWh/yr)	Fan Electric Use (kWh/yr)	Pump Electric Use (1) (kWh/yr)	Lighting Electric Use (kWh/yr)	Receot. Electric Use (kWh/yr)	Total Electric Use (kWh/yr)	Peak Electric Demand (kW)	Total Gas Use (MBtu/yr)	Total Energy Use (MBtu/yr)
Baseline	6,317,652	8,200	0	155,220	0	295,749	0	459,169	0	6,318	7,885
Wall Insulation	6,241,559	8,200	0	152,300	0	295,749	0	456,249	0	6,242	7,799
Savings (Loss)	76,093	0	0	2,920	0	0	0	2,920	0	76	86
Roof Insulation	2,208,442	6,937	0	47,943	0	295,749	0	350,629	0	2,208	3,405
Savings (Loss)	4,109,210	1,263	0	107,277	0	0	0	108,540	0	4,109	4,480
Insulated Glass	6,287,502	8,200	0	154,555	0	295,749	0	458,504	0	6,288	7,852
Savings (Loss)	30,150	0	0	665	0	0	0	665	0	30	32
Weatherstripping and Caulk	6,310,442	8,200	0	155,042	0	295,749	0	458,991	0	6,310	7,877
Savings (Loss)	7,210	0	0	178	0	0	0	178	0	7	8
Destratification Fans	5,806,827	7,984	0	219,168	0	295,749	0	522,901	0	5,807	7,591
Savings (Loss)	510,825	216	0	(63,948)	0	0	0	(63,732)	0	511	293
Radiant Heaters	6,010,785	7,794	0	0	0	295,749	0	303,543	0	6,011	7,047
Savings (Loss)	306,867	406	0	155,220	0	0	0	155,626	0	307	838
Loading Dock Seals	5,981,313	8,085	0	146,557	0	295,749	0	450,391	0	5,981	7,518
Savings (Loss)	336,339	115	0	8,663	0	0	0	8,778	0	336	366
Lighting Controls	6,532,542	8,239	0	149,773	0	159,705	0	317,717	0	6,533	7,617
Savings (Loss)	(214,890)	(39)	0	5,447	0	136,044	0	141,462	0	(215)	268
Continuous Boiler Operation	8,905,955	11,988	0	232,830	0	295,749	0	540,567	0	8,906	10,751
Savings (Loss)	(2,588,303)	(3,788)	0	(77,610)	0	0	0	(81,398)	0	(2,588)	(2,866)

APPENDIX D

ECO PROJECT BACKUP CALCULATIONS

D-1 MCA PROJECT 1
D-2 MCA PROJECT 2
D-3 LOW-COST/NO-COST PROJECT 1
D-4 NAF

APPENDIX D-1 MCA PROJECT 1

ECO-1, ADD DUCT INSULATION
ECO-1, ADD ROOF INSULATION
ECO-5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS
ECO-7, CONTROL HOT WATER CIRCULATION PUMPS
ECO-11, REPLACE STREET LIGHTS
ECO-12, REVISE OR REPAIR HVAC CONTROLS
ECO-14, RADIANT HEATERS
ECO-15, SEPARATE SWITCHES TO CONTROL LIGHTING
ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KITS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) STUDY: GPJ1
INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 LCCID 1.065
PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
FISCAL YEAR 1992 DISCRETE PORTION NAME: MCA PROJECT 1
ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	666557.
B. SIOH	\$	36661.
C. DESIGN COST	\$	39994.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	743212.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	3363.	\$ 25125.	11.11	279142.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	6919.	\$ 32312.	14.45	466905.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		10282.	\$ 57437.		\$ 746046.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	10.59	\$	8410.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$	89062.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ 89062.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 246195.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS\ ECONOMIC\ LIFE))$ \$ 65847.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 835108.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.12
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.29

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
MCA PROJECT 1

EMC PROJECT: #3105.000
 DATE: 02-Sep-92
 FILE: FNLECO.WK3
 PREPARED BY: CMD
 CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY COST	DISCOUNT FACTOR	DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG	14.45 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE	11.11 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW	10.59 UPW

PROJECT ECONOMIC LIFE 15 YEARS

ECO #	ECONOMIC LIFE (YRS)	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON- ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
ECO-1D	25	0	4,596	38	54	\$295	\$0	\$0	\$295	\$2,040	3.0	6.9
ECO-1R	25	0	108,540	4,109	4,479	\$21,957	\$0	\$0	\$21,957	\$419,503	1.2	19.1
ECO-5	15	11	71,225	0	243	\$1,816	\$1,102	\$0	\$2,918	\$37,154	1.2	12.7
ECO-7	15	0	124,564	233	658	\$4,271	\$0	\$0	\$4,271	\$9,868	4.6	2.3
ECO-11	25	0	4,928	0	17	\$126	\$0	\$174	\$300	\$2,682	1.7	8.9
ECO-12	15	57	285,187	302	1,274	\$8,683	\$5,852	\$127	\$14,661	\$57,547	2.9	3.9
ECO-14-HEAT	15	0	263,425	2,007	2,906	\$16,090	\$0	\$0	\$16,090	\$166,198	1.3	10.3
ECO-15	25	11	47,766	(18)	145	\$1,136	\$1,141	\$0	\$2,277	\$30,072	1.1	13.2
ECO-18	25	7	63,860	0	218	\$1,635	\$748	(\$734)	\$1,649	\$10,296	2.5	6.2
TOTAL		86	974,092	6,671	9,994	\$56,008	\$8,843	(\$433)	\$64,418	\$735,360	1.1	11.4

ECO-1, ROOF INSULATION

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-1 ROOF INSULATION

ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 3173436.
B. SIOH	\$ 174539.
C. DESIGN COST	\$ 190407.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 3538382.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	3041.	\$ 22723.	15.61	354701.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	34889.	\$ 162932.	23.77	3872885.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		37930.	\$ 185654.		\$ 4227586.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) 14.53

(2) DISCOUNTED SAVING/COST (3A X 3A1) \$ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 1395103.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 185654.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 4227586.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.19

(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 19.06

ROOF INSULATION SAMPLE CALCULATION, ECO #1 BUILDING 111

Given:

Roof Area	= 2,150 ft ²	- from bldg plans
Existing Roof U-value	= 0.202 Btuh / hr °F ft ²	- from survey notes
Improved Roof U-value	= 0.042 Btuh / hr °F ft ²	- from survey notes
Gas Savings Factor	= 0.0083 MBtu / UA	- from Bldg 100 simulation
Electric Savings Factor	= 1.8 kWh / UA	- from Bldg 100 simulation
Demand Savings Factor	= 0.0 kW	- from Bldg 100 simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Roof UA:

$$(2,150 \text{ ft}^2) * (0.202 \text{ Btuh / hr } ^\circ\text{F ft}^2) = 434.3 \text{ Btuh / hr } ^\circ\text{F}$$

Improved Roof UA:

$$(2,150 \text{ ft}^2) * (0.042 \text{ Btuh / hr } ^\circ\text{F ft}^2) = 90.3 \text{ Btuh / hr } ^\circ\text{F}$$

Delta UA:

$$434.3 - 90.3 = 344.0 \text{ Btuh / hr } ^\circ\text{F}$$

Peak Demand Savings:

$$(344.0 \text{ UA}) * (0.0 \text{ kW / UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

- Gas:	(344.0 UA) * (0.0083 MBtu / UA)	= 2.9 MBtu
- Electric:	(344.0 UA) * (1.8 kWh / UA)	= 619 kWh

Annual Cost Savings:

$$(2.9 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (619 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$29 / \text{yr}$$

Estimated Construction Cost:

\$0.68 / ft² of wall - from engineer's cost estimate

$$(\$0.68 / \text{ft}^2) * (2,150 \text{ ft}^2) = \$1,462$$

$$\$1,462 + (\$1,462 * .055 \text{ SIOH}) + (\$1,462 * .06 \text{ DESIGN}) = \$1,630$$

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 — Roof Insulation

CLIENT CONTRACT NO: DACA21 - 91 - C - 0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 02-Sep-92
FILE: ECO-1R.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
207	0	108,540	4,109	4,479	\$21,957	\$0	\$0	\$21,957	\$419,503	1.2	19
TOTAL	\$0	\$108,540	\$4,109	\$4,479	\$21,957	\$0	\$0	\$21,957	\$419,503	1.2	19

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 1 - Roof Insulation

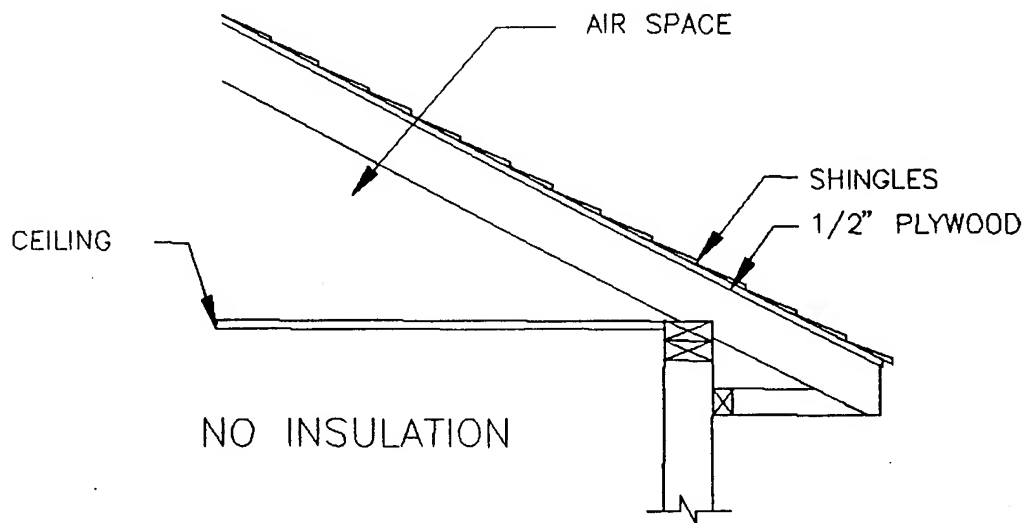
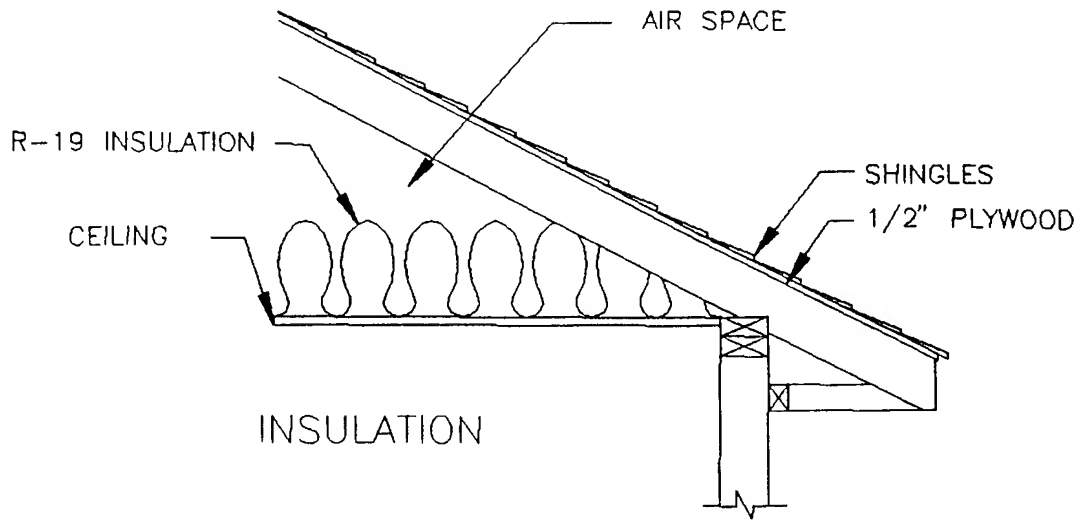
EMC PROJECT: #3105.000
 DATE: 15-APR-92
 FILE: ECO-1R.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG #	ROOF AREA (ft²)	EXIST ROOF U-VALUE	EXIST ROOF UA	IMPRVD ROOF U-VALUE	IMPRVD ROOF UA	DELTA UA	DEMAND SAVINGS (kW/UA)	ELECTRIC SAVINGS (kWh/UA)	GAS SAVINGS (MBtu/UA)	PEAK DEMAND SAVINGS (kW/yr)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	UNIT CONST COST (\$/ft²)	CONST COST (\$)
207	149,300	0.518	77,337	0.048	7,166	70,171	0	1.5	0.059	0	108,540	4,109	\$2.52	\$376,236
505	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
506	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
507	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
508	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
509	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
510	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
511	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
512	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
513	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720
514	111,000	0.518	57,498	0.048	5,328	52,170	0	1.5	0.059	0	78,255	3,078	\$2.52	\$279,720

[illegible]

D-1.2.6



ECO-1, DUCT INSULATION

DUCT INSULATION SAMPLE CALCULATION, ECO #1 BUILDING G101

Given:

Duct Perimeter	= 80 in	- from bldg plans / survey notes
Duct Length	= 45 ft	- from bldg plans / survey notes
Existing Ins. Thickness	= 0.5 in	- from survey notes
Improved Ins. Thickness	= 2.0 in	- assumed
Ins. Thermal Cond.	= 0.26 Btuh in / ft ² °F	- from ASHRAE
Inner Film R-Value	= 0.22 ft ² °F / Btuh	- from ASHRAE
Outer Film R-Value	= 0.65 ft ² °F / Btuh	- from ASHRAE
Duct Temp. -Heating	= 90 °F	- assumed
Duct Temp. -Cooling	= 55 °F	- assumed
Amb. Temp. Winter	= 75 °F	- assumed
Amb. Temp. Summer	= 90 °F	- assumed
Delta Enthalpy - Summer	= 15.6 Btu / lbm	- assumed
Leakage Class w/o insul.	= 48 cfm / 100ft ²	- SMACNA
Leakage Class w/ added insul	= 24 cfm / 100 ft ²	- SMACNA
Static Pressure	= 0.5 in. w.g.	- assumed
Gas Heater Efficiency	= 75%	- assumed
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Duct Surface Area:

$$(80 \text{ in} / 12 \text{ in} / \text{ft}) * (45 \text{ ft}) = 300 \text{ ft}^2$$

Existing Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F}) / (0.5 \text{ in})) = 1.92 \text{ ft}^2 \text{ °F} / \text{Btuh}$$

Existing U-Value:

$$1 / (0.22 + 1.92 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.36 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

Improved Insulation R-Value:

$$1 / ((0.26 \text{ Btuh in} / \text{ft}^2 \text{ °F}) / (2.0 \text{ in})) = 7.69 \text{ ft}^2 \text{ °F} / \text{Btuh}$$

Improved U-Value:

$$1 / (0.22 + 7.69 + 0.65 \text{ ft}^2 \text{ °F} / \text{Btuh}) = 0.12 \text{ Btuh} / \text{ft}^2 \text{ °F}$$

Existing Leakage Rate:

$$(48 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 30.6 \text{ cfm} / 100 \text{ ft}^2$$

Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 75 \text{ } ^\circ\text{F}) / 0.75 = 2,160 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm } ^\circ\text{F}) * (91.8 \text{ cfm})(90 - 75 \text{ } ^\circ\text{F})}{0.75} = 2020 \text{ Btuh}$$

Total

$$\begin{aligned} (2020 + 2160) &= 4180 \text{ Btuh} \\ (4180 \text{ Btuh}) * (4380 \text{ hrs}) &= 18.3 \text{ MBtu} \end{aligned}$$

Summer (electric):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 55 \text{ } ^\circ\text{F}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.38 \text{ kW}$$

Total

$$\begin{aligned} (0.22 + 0.38) &= 0.60 \text{ kW} \\ (0.60 \text{ kW}) * (4380 \text{ hrs}) &= 2628 \text{ kwh} \end{aligned}$$

Improved Energy Usage:

Winter (gas):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 75 \text{ } ^\circ\text{F}) / 0.75 = 701 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm } ^\circ\text{F}) * (45.9 \text{ cfm})(90 - 75 \text{ } ^\circ\text{F})}{0.75} = 1010 \text{ Btuh}$$

Total

$$\begin{aligned} (7.1 + 1010) &= 1711 \text{ Btuh} \\ (1711 \text{ Btuh}) * (4380 \text{ hrs}) &= 7.5 \text{ MBtu} \end{aligned}$$

Summer (electric):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 55 \text{ } ^\circ\text{F}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.071 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) * (45.9 \text{ cfm}) (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.19 \text{ kw}$$

Total

$$\begin{aligned} (0.071 + 0.19) &= 0.26 \text{ kw} \\ (0.26 \text{ kw}) * (4380 \text{ yrs}) &= 1134 \text{ kwh} \end{aligned}$$

Peak Demand Savings: 0 kW

Annual Energy Savings:

$$\begin{aligned} \text{- Electric:} & (2628 - 1134 \text{ kWh}) = 1494 \text{ kW} \\ \text{- Gas:} & (18.3 - 7.5 \text{ MBtu}) = 10.8 \text{ MBtu} \end{aligned}$$

Annual Cost Savings:

$$(10.8 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (1494 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$89 / \text{yr}$$

Estimated Construction Cost:

\$3.05 / ft² of insulation - from engineer's cost estimate

$$(\$3.05 / \text{ft}^2) * (300 \text{ ft}^2) = \$915$$

$$\$915 + (\$915 * .055 \text{ SIOH}) + (\$915 * .06 \text{ DESIGN}) = \$1,020$$

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 – Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-1DM.WK3
PREPARED BY: CMD
CHECKED BY: CEL

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
G735	0	3,770	32	45	\$246	\$0	\$0	\$246	\$1,020	5.0	4.2
G101	0	826	6	9	\$49	\$0	\$0	\$49	\$1,020	1.0	20.8
TOTAL	0	4,596	38	54	\$295	\$0	\$0	\$295	\$2,040	3.0	6.9

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 1 - Duct Insulation

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: OEL

NEW DUCT INSULATION CONDITION

UNIT CONST COST: \$3.05 / ft²

BLDG #	DUCT PER. (in)	DUCT LENGTH (ft)	SURFACE AREA (ft²)	R OUTER FILM	R INNER FILM	R INS.	U	THERMAL COND. (Btu in/ h ft² F)	INS. THICK. (in)	LEAK CLASS	STATIC PRESS (in. w.g.)	LEAK RATE (cfm/ 100 ft²)	TOTAL LEAK (cfm)	WINTER				SUMMER			
														DUCT TEMP (F)	AMB TEMP (F)	DUCT TEMP (F)	AMB TEMP (F)	DUCT TEMP (F)	AMB TEMP (F)	DELTA ENTH	
G101	80	45	300	0.65	0.220	7.69	0.12	0.26	2	0	0.5	0.0	0.0	90	75	55	90	55	90	15.6	
G735	80	25	167	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	25.5	90	75	55	90	55	90	15.6	
	160	10	133	0.65	0.220	7.69	0.12	0.26	2	24	0.5	15.3	20.4	90	75	55	90	55	90	15.6	
TOTAL																					

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL

NEW DUCT INSULATION CONDITION

UNIT CONST \$3.05 / ft²

BLDG #	IMPROVED ENERGY LOSSES					ANNUAL ENERGY SAVINGS			TOTAL CONST COST (\$)
	WINTER		SUMMER		TOTAL (kW)	GAS (MBtu/yr)	ELECTRIC (kW/yr)	GAS (MBtu/yr)	ELECTRIC (kW/yr)
	INSUL (Btu/h)	LEAK (Btu/h)	INSUL (kW)	LEAK (kW)					
G101	700.7	---	0.03	---	0.03	3.1	134.2	6.3	825.7
G735	389.3	560.8	0.02	0.10	0.12	4.2	531.5	17.5	2094.5
	311.4	448.6	0.01	0.08	0.10	3.3	425.2	14.0	1675.6
TOTAL								31.6	3770.2
									\$915.00
									\$508.33
									\$406.67
									\$915.00

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT McPHERSON

ECO: 1. DUCT INSULATION

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EXISTING DUCT INSULATION CONDITION

EMC PROJECT: #3105.000
DATE: 10-JUL-92
FILE: ECO-1DG.WK3
PREPARED BY: CMD
CHECKED BY: CEL

BLDG #	ENERGY LOSSES						ANNUAL	
	WINTER		SUMMER		TOTAL		GAS	ELECTRIC
	INSUL (Btu/h)	LEAK (Btu/h)	INSUL (KW)	LEAK (KW)	(KW)	(KW)	(MBtu/yr)	(kW/yr)
G101	2148.2	--	0.22	--	0.22	0.22	9.4	960.0
G735	3831.4	1121.6	0.39	0.21	0.60	0.60	21.7	2626.0
	3065.1	897.3	0.31	0.17	0.48	0.48	17.4	2100.8

[illegible]

ECO-5, INSTALL HIGH EFFICIENCY ELECTRIC MOTORS

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25
LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-5 HIGH EFFICIENCY MOTOR

ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$ 33322.
B. SIOH	\$ 1833.
C. DESIGN COST	\$ 2000.
D. SALVAGE VALUE COST	-\$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$ 37155.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	243.	\$ 1816.	15.61	28341.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		243.	\$ 1816.		\$ 28341.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$ 1102.
(1) DISCOUNT FACTOR (TABLE A)	14.53
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$ 16012.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$ 16012.
D. PROJECT NON ENERGY QUALIFICATION TEST	
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$ 9352.
A IF 3D1 IS = OR > 3C GO TO ITEM 4	
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E	1.01
C IF 3D1B IS = > 1 GO TO ITEM 4	
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY	

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS \text{ ECONOMIC LIFE}))$ \$ 2918.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 44353.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.19
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) $SPB=1E/4$ 12.73

**HIGH-EFFICIENCY MOTOR REPLACEMENT SAMPLE CALCULATION, ECO #5
BUILDING 40**

Given:

Motor Horsepower	= 3 hp	-from field survey
Operation Hours	= 8,760 hrs / yr	-from field survey
Standard Motor Efficiency	= 84%	-from standard motor info
High Eff Motor Efficiency	= 88.5%	-from high efficiency motor info
Motor Load Factor	= 85%	-assumed
Gas Cost	= \$4.67 / MBtu	-from utility rate analysis
Electric Cost	= \$0.0255 / kWh	-from utility rate analysis
Demand Cost	= \$8.85 / kW	-from utility rate analysis

Existing Demand:

$$\frac{(3 \text{ hp}) * (0.746 \text{ kw} / \text{hp}) * (85\%)}{(84\%)} = 2.26 \text{ kw}$$

Improved Demand:

$$\frac{(3 \text{ hp}) * (0.746 \text{ kw} / \text{hp}) * (85\%)}{(88.5\%)} = 2.15 \text{ kw}$$

Peak Demand Savings:

$$2.26 \text{ kW} - 2.15 \text{ kW} = 0.11 \text{ kW}$$

Annual Electric Savings:

$$(0.11 \text{ kW}) * (8,760 \text{ hrs} / \text{yr}) = 964 \text{ kWh} / \text{yr}$$

Annual Cost Savings:

$$(0.0 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (964 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.11 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + 0.95 * 8) = \$36 / \text{yr}$$

Estimated Construction Cost:

$$\$624 / 3 \text{ hp motor} \quad \text{-from engineer's cost estimate}$$

Total Leakage

$$(30.6 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 91.8 \text{ cfm}$$

Improved Leakage Rate

$$(24 \text{ cfm} / 100 \text{ ft}^2) * (0.5)^{0.65} = 15.3 \text{ cfm} / 100 \text{ ft}^2$$

Total Leakage

$$(15.3 \text{ cfm} / 100 \text{ ft}^2) * (300 \text{ ft}^2) = 45.9 \text{ cfm}$$

Existing Energy Usage:

Winter (gas):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 75 \text{ } ^\circ\text{F}) / 0.75 = 2,160 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm } ^\circ\text{F}) * (91.8 \text{ cfm}) * (90 - 75 \text{ } ^\circ\text{F})}{0.75} = 2020 \text{ Btuh}$$

Total

$$(2020 + 2160) = 4180 \text{ Btuh}$$
$$(4180 \text{ Btuh}) * (4380 \text{ hrs}) = 18.3 \text{ MBtu}$$

Summer (electric):

Insulation

$$(0.36 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 55 \text{ } ^\circ\text{F}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.22 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) + (91.8 \text{ cfm}) * (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.38 \text{ kW}$$

Total

$$(0.22 + 0.38) = 0.60 \text{ kW}$$
$$(0.60 \text{ kW}) * (4380 \text{ hrs}) = 2628 \text{ kwh}$$

Improved Energy Usage:

Winter (gas):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 75 \text{ } ^\circ\text{F}) / 0.75 = 701 \text{ Btuh}$$

Leakage

$$\frac{(1.1 \text{ Btuh} / \text{cfm } ^\circ\text{F}) * (45.9 \text{ cfm})(90 - 75 \text{ } ^\circ\text{F})}{0.75} = 1010 \text{ Btuh}$$

Total

$$(7.1 + 1010) = 1711 \text{ Btuh}$$
$$(1711 \text{ Btuh}) * (4380 \text{ hrs}) = 7.5 \text{ MBtu}$$

Summer (electric):

Insulation

$$(0.12 \text{ Btuh} / \text{ft}^2 \text{ } ^\circ\text{F}) * (300 \text{ ft}^2) * (90 - 55 \text{ } ^\circ\text{F}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.071 \text{ kW}$$

Leakage

$$(4.5 \text{ lbm} / \text{cfm hr}) * (45.9 \text{ cfm}) (15.6 \text{ Btu} / \text{lbm}) * (5.83\text{E-}5 \text{ kW} / \text{Btuh}) = 0.19 \text{ kW}$$

Total

$$(0.071 + 0.19) = 0.26 \text{ kW}$$
$$(0.26 \text{ kW}) * (4380 \text{ yrs}) = 1134 \text{ kwh}$$

Peak Demand Savings: 0 kW

Annual Energy Savings:

- Electric:	(2628 - 1134 kWh)	= 1494 kW
- Gas:	(18.3 - 7.5 MBtu)	= 10.8 MBtu

Annual Cost Savings:

$$(10.8 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (1494 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$89 / \text{yr}$$

Estimated Construction Cost:

\$3.05 / ft² of insulation - from engineer's cost estimate

$$(\$3.05 / \text{ft}^2) * (300 \text{ ft}^2) = \$915$$

$$\$915 + (\$915 * .055 \text{ SIOH}) + (\$915 * .06 \text{ DESIGN}) = \$1,020$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 5 - Install High Efficiency Electric Motors

EMC PROJECT: #3105.000
 DATE: 17-Jul-92
 FILE: ECO-5.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW

Economic Life: 25 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	4	25,493	0	87	\$650	\$455	\$0	\$1,106	\$10,132	1.7	9.2
214	1	10,031	0	34	\$256	\$141	\$0	\$397	\$5,601	1.1	14.1
213	4	26,425	0	90	\$674	\$397	\$0	\$1,071	\$16,122	1.0	15.1
207	1	5,364	0	18	\$137	\$63	\$0	\$200	\$3,041	1.0	15.2
103	0	3,912	0	13	\$100	\$46	\$0	\$146	\$2,259	1.0	15.5
TOTAL	11	71,225	0	243	\$1,816	\$1,102	\$0	\$2,918	\$37,154	1.2	12.7

EMC ENGINEERS, INC.

PROJECT: FORT MCPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER/ UNDER SIZED	NAMEPLATE			MEASURED			LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
				HP	FLA	VOLTS	EFF	AMPS	PF	VOLTS					
101	HWP 1	Off	OVER OVER	30.0	85.0	200		90.6	0.84	203	85%	90.2%	93.6%	4380	3,355
	HWP 2			30.0	85.0	200					85%	90.2%	93.6%		
	CWP 1			10.0	29.0	208		16.0	0.75	205	85%	87.5%	91.7%	4380	1,454
	CWP 2			10.0	29.0	208		16.7	0.72	204	85%	87.5%	91.7%	4380	1,454
	AHU 1			2.0	6.0	208	82.5%				85%	82.5%	86.5%	8760	623
	AHU 2			7.5	24.4	200					85%	86.5%	91.7%	8760	2,731
	AHU 3			5.0	15	208	62.5%				85%	89.5%	1.53	8760	13,406
102	AHU 1 FLR 4	No Accel	OVER OVER	2.0	6	208	82.5%				85%	82.5%	0.07	8760	623
	AHU 3 FLR 4			5.0	15	200					85%	85.5%	0.17	8760	1,452
	AHU 4			1.0	3.8	200					85%	77.0%	0.09	4380	396
	TOTAL			102.5									4.4		25,493
	AHU 1			1.0	3.0	208					85%	77.0%	0.09	8760	792
	AHU 2			1.0	3.0	208					85%	77.0%	0.09	8760	792
	TOTAL			2.0									0.2		1,585
103	AHU 1	No Accel	OVER OVER	3.0	9.6	200		9.6	0.80	200	85%	84.0%	88.5%	8760	1,009
	ROOF AHU 1			5.0							85%	85.5%	0.17	8760	1,452
	ROOF AHU 2			5.0							85%	85.5%	0.17	8760	1,452
	TOTAL			13.0									0.4		3,912
	AHU 1			3.0	11.4	200					85%	84.0%	88.5%	8760	1,009
	AHU 2			3.0	11.4	200					85%	84.0%	88.5%	8760	1,009
	AHU 3			1.5	8.0	230					85%	77.0%	0.14	8760	1,188
207	TOTAL	No Accel	OVER OVER	7.5									0.4		3,206
	AHU 1			3.0	9.6	200					85%	84.0%	88.5%	8760	1,009
	AHU 2			5.0	14.8	200	0.855				85%	85.5%	0.17	8760	1,452
	AHU 3			5.0	14	208					85%	85.5%	0.17	8760	1,452
	AHU 4			5	14.2	208					85%	85.5%	0.17	8760	1,452
	TOTAL			18.0									0.6		5,364
	TOTAL														

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 5 - Install High Efficiency Electric Motors

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-5.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG. #	EQUIPMENT DESC	NOTE	OVER/ UNDER SIZED	NAMEPLATE			MEASURED			LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
				HP	FLA	VOLTS	EFF	AMPS	PF	VOLTS					
213	AHU 1A			3.0	9	200					85%	84.0%	88.5%	0.12	1,009
	AHU 2B		OVER	15.0	49	200	0.875	27.7	0.81	208	85%	87.5%	92.4%	0.58	8760
	AHU 3B			2.0	6.6	200					85%	80.0%	86.5%	0.12	8760
	AHU 1			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	AHU 2			7.5	21	230					85%	86.5%	91.7%	0.31	8760
	AHU 3			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	AHU 4			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	AHU 5			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	AHU 6			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	AHU 7			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	AHU 8			5	14.4	230					85%	85.5%	89.5%	0.17	8760
	CWP 1			10	26.6	208	0.865				85%	86.5%	91.7%	0.42	4380
	CWP 2			10	26.6	208	0.865				85%	86.5%	91.7%	0.42	4380
	CWP 3			2	7	208					85%	80.0%	86.5%	0.09	4380
	HWP 3			1	3.75	208					85%	86.5%	91.7%	0.31	4380
214	HWP2	Off		7.5	21	230					85%	84.0%	88.5%	0.12	2190
	COND PUMP 1			7.5	21	230					85%	84.0%	88.5%	0.12	2190
	COND PUMP 2			3	9	200					85%	84.0%	88.5%	0.12	2190
TOTAL				106.5	19.6	460		16	0.81	472				3.9	26,425
308	HWP		OVER	15.0	49	460		25.9	0.70	474	85%	88.5%	92.4%	0.45	4380
	AHU			40.0							85%	91.0%	94.1%	0.92	8,044
	TOTAL			55.0										1.4	10,031
400	AHU 1			3.0	9.6	200					85%	84.0%	88.5%	0.12	8760
	AHU 2			2.0	6.2	230					85%	80.0%	86.5%	0.12	8760
	COND. PUMP 1			3.0	8.2	208					85%	84.0%	88.5%	0.12	8760
400	COND. PUMP 2			3.0	8.2	208					85%	84.0%	88.5%	0.12	8760
	TOTAL			11.0										0.5	4,070
400	CIRC. FAN 1			3.0	8.4	220					85%	84.0%	88.5%	0.12	2190
	CIRC. FAN 2	Off		3.0	8.4	220					85%	84.0%	88.5%	0.12	2190
	AHU 1			10	26	200		21		206	85%	87.5%	91.7%	0.33	8760
400	AHU 2			5	9	200	0.84				85%	84.0%	89.5%	0.23	8760
	COND. PUMP 1			7.5	21	200					85%	86.5%	91.7%	0.31	2190
	COND. PUMP 2			7.5	21	200					85%	86.5%	91.7%	0.31	2190
TOTAL				36.0										1.4	6,557

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	NOTE	OVER / UNDER SIZED	NAMEPLATE			MEASURED			LOAD FACTOR (%)	EXIST EFF	IMPRVD EFF	DEMAND SAVINGS (kW)	HRS/ YEAR	ELECTRIC SAVINGS (kWh/yr)
				HP	FLA	VOLTS	EFF	AMPS	PF	VOLTS					
512	AHU 1			5.0	14.8	200					85%	85.5%	89.5%	0.17	1,452
	AHU 2			3.0	7.6	208					85%	84.0%	88.5%	0.12	1,009
	TOTAL			8.0											2,461
735	AHU 1		OVER	10	30	200		23	0.76	204	85%	87.5%	91.7%	0.33	727
	TOTAL			10.0										0.3	727
935	HWP 1			5.0	12.8	230					85%	85.5%	89.5%	0.17	726
	HWP 2			3.0	9	200					85%	84.0%	88.5%	0.12	1,009
	AHU 1			2.0	6.1	208					85%	80.0%	86.5%	0.12	522
	AHU 4			1.5	4.8	208					85%	77.0%	86.5%	0.14	1,188
	AHU 5			5.0	14.7	208					85%	85.5%	89.5%	0.17	726
	TOTAL			16.5										0.7	4,171

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL (\$)	OH&B 15%	PROFIT 10%	SUB TOTAL (\$)	CONT 15%	TOTAL (\$)
		MOTOR (\$)	LABOR (\$)						
101	HWP 1	\$1,639	\$152	\$1,791	\$269	\$179	\$2,239	\$336	\$2,575
	HWP 2								
	CWP 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	CWP 2	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	AHU 1	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 2	\$316	\$72	\$388	\$103	\$69	\$861	\$129	\$990
	AHU 3	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 1 FLR 4	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 3 FLR 4	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 4	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
TOTAL				\$9,087					
102	AHU 1	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
	AHU 2	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
TOTAL				\$1,035					
103	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	ROOF AHU 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	ROOF AHU 2	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	TOTAL								\$2,026
133	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 3	\$328	\$68	\$396	\$59	\$40	\$495	\$74	\$569
TOTAL									\$1,816
207	AHU 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 3	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 4	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
TOTAL									\$2,727

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 5 - Install High Efficiency Electric Motors

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-Jul-92
FILE: ECO-5.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL	OH&B 15%	PROFIT 10%	SUB TOTAL	CONT 15%	TOTAL (\$)
213	AHU 1A	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 2B	\$985	\$114	\$1,099	\$165	\$110	\$1,374	\$206	\$1,580
	AHU 3B	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 2	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	AHU 3	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 4	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 5	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 6	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 7	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 8	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	CWP 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	CWP 2	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	CWP 3	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
214	HWP 3	\$292	\$68	\$360	\$54	\$36	\$450	\$67	\$517
	HWP 1	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	HWP2								
	COND PUMP 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
308	COND PUMP 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	TOTAL								
		\$985	\$114	\$1,099	\$165	\$110	\$1,374	\$206	\$1,580
400	AHU	\$2,212	\$183	\$2,395	\$359	\$239	\$2,994	\$449	\$3,443
	TOTAL								
		\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
		\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
400	COND. PUMP 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	COND. PUMP 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	TOTAL								
		\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
400	CIRC. FAN 1	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	CIRC. FAN 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	AHU 2	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
400	COND. PUMP 1	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
	COND. PUMP 2	\$616	\$72	\$688	\$103	\$69	\$861	\$129	\$990
400	TOTAL								
									\$5,115

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 5 - Install High Efficiency Electric Motors

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-5.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

BLDG. #	EQUIPMENT DESC	COST		SUB TOTAL (\$)	OH&B 15%	PROFIT 10%	SUB TOTAL (\$)	CONT 15%	TOTAL (\$)
		MOTOR (\$)	LABOR (\$)						
512	AHU 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	AHU 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	TOTAL								\$1,325
735	AHU 1	\$750	\$76	\$826	\$124	\$83	\$1,033	\$155	\$1,188
	TOTAL								\$1,188
935	HWP 1	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	HWP 2	\$366	\$68	\$434	\$65	\$43	\$542	\$81	\$624
	AHU 1	\$359	\$68	\$427	\$64	\$43	\$534	\$80	\$614
	AHU 4	\$328	\$68	\$396	\$59	\$40	\$495	\$74	\$569
	AHU 5	\$420	\$68	\$488	\$73	\$49	\$610	\$91	\$701
	TOTAL								\$3,209

MOTORS OPERATING AT FULL LOAD (1800 RPM)				ELEC. COST: \$0.0255 /KWH DEMAND COST: \$8.85 /KW					
H.P.	STANDARD EFFICIENCY	PREMIUM EFFICIENCY	DIFFERENTIAL COST *	HOURS OF OPERATION PER YEAR					
				2000 HRS SAVINGS/ YEAR	SIMPLE PAYBACK	4000 HRS SAVINGS/ YEAR	SIMPLE PAYBACK	8760 HRS SAVINGS/ YEAR	SIMPLE PAYBACK
1	77.0%	86.5%	\$148	\$14	10.6	\$19	8.0	\$29	5.0
1.5	77.0%	86.5%	\$167	\$21	8.0	\$28	6.0	\$44	3.8
2	80.0%	86.5%	\$178	\$18	9.7	\$24	7.3	\$39	4.6
3	84.0%	88.5%	\$172	\$18	9.7	\$24	7.3	\$38	4.6
5	85.5%	89.5%	\$201	\$25	7.9	\$34	5.9	\$54	3.7
7.5	86.5%	91.7%	\$305	\$48	6.4	\$64	4.8	\$102	3.0
10	87.5%	91.7%	\$370	\$51	7.3	\$68	5.4	\$108	3.4
15	88.5%	92.4%	\$495	\$70	7.1	\$93	5.3	\$148	3.3
20	90.2%	93.0%	\$579	\$65	8.9	\$87	6.7	\$138	4.2
25	90.2%	93.6%	\$646	\$98	6.6	\$131	4.9	\$208	3.1
30	90.2%	94.1%	\$729	\$134	5.4	\$179	4.1	\$285	2.6
40	91.0%	94.1%	\$1,042	\$141	7.4	\$188	5.5	\$299	3.5
50	91.7%	94.5%	\$1,214	\$157	7.7	\$210	5.8	\$334	3.6
60	91.7%	94.5%	\$1,515	\$189	8.0	\$252	6.0	\$401	3.8
75	92.2%	94.5%	\$1,743	\$193	9.0	\$257	6.8	\$409	4.3
100	93.0%	94.6%	\$2,666	\$177	15.0	\$236	11.3	\$376	7.1

D-1.4.12

ECO-7, CONTROL HOT WATER CIRCULATION PUMPS

STUDY: GECO15
LCCID 1.062

LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) REGION NOS. 4 CENSUS: 3
 INSTALLATION & LOCATION: FT. GILLEM
 PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
 FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-7 HW PUMP CONTROL
 ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT	\$	9868.
A. CONSTRUCTION COST	\$	543.
B. SIOH	\$	592.
C. DESIGN COST	-	0.
D. SALVAGE VALUE COST	\$	11003.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)		

2. ENERGY SAVINGS (+) / COST (-)
 ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	425.	\$ 3176.	11.11	35290.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	233.	\$ 1088.	14.45	15723.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		658.	\$ 4265.		\$ 51013.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	0.
(1) DISCOUNT FACTOR (TABLE A)	10.59	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) / COST(-) (3A2+3Bd4) \$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST \$ 16834.

(1) 25% MAX NON ENERGY CALC (2F5 X .33)
 A IF 3D1 IS = OR > 3C GO TO ITEM 4
 B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____
 C IF 3D1B IS = > 1 GO TO ITEM 4
 D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 4265.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 51013.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.64
 (IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 2.58

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM

ECO: 7 – Hot Water Pumps

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 15-APR-92

FILE: ECO-7.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

ENERGY COST	DISCOUNT FACTOR
Gas Savings \$4.70 / MBtu	14.45 UPWG
Electric Savings \$0.0255 / kWh	11.11 UPWE
Demand Savings \$8.85 / kW	10.59 UPW
Economic Life: 15 yrs	

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	0	124,564	233	658	\$4,271	\$0	\$0	\$4,271	\$9,868	4.6	2.3

ECO-12, REVISE OR REPAIR HVAC CONTROLS

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO15
LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-12 HVAC CONTROLS

ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	51612.
B. SIOH	\$	2839.
C. DESIGN COST	\$	3097.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	57548.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	973.	\$ 7272.	11.11	80794.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	302.	\$ 1410.	14.45	20379.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		1275.	\$ 8683.		\$ 101174.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	5979.
(1) DISCOUNT FACTOR (TABLE A)	10.59	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	63318.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	63318.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	33387.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 2.34		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))	\$	14662.
5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C)	\$	164491.
6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALIFY)	(SIR)=(5 / 1E)=	2.86
7. SIMPLE PAYBACK PERIOD (ESTIMATED)	SPB=1E/4	3.93

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 12 - HVAC Controls

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-12.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / kW	10.59 UPW
Economic Life: 15 yrs		

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON- ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
101	57	285,187	302	1,274	\$8,683	\$5,852	\$127	\$14,661	\$57,547	2.9	3.9

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 12 - HVAC Controls

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 15-APR-92
FILE: ECO-12.WK3
PREPARED BY: R. GERRANS
CHECKED BY:

BLDG #	EQUIPMEN	#	UNIT COST (\$/ea)	TOTAL COST (\$)
G101				\$51,612.00
	DDC Panel	1	\$8,050.00	
	AHU	3	\$3,154.00	
	Chiller	6	\$3,577.00	
	Conv	1	\$4,384.00	
	Boiler	2	\$4,127.00	

EQUIPMENT COSTS:

DDC Panel	\$8,050
FCU	\$3,154
AHU	\$3,154
MZ AHU	\$9,192
Chiller	\$3,577
Conv	\$4,384
Boiler	\$4,127

INVITATION NO./CONTRACT NO.

DA FORM 5418-85

COST ESTIMATE ANALYSIS										INVITATION NO./CONTRACT NO. DACA 21-91-C-0097				EFFECTIVE PRICING DATE APR. 92 DRAWING NO.		DATE PREPARED 16-Apr-92 SHT OF	
PROJECT Ft. McPherson & Ft. Gillem ESOS Study LOCATION Ft. McPherson & Ft. Gillem										X <input type="checkbox"/> CODE A <input type="checkbox"/> CODE B <input type="checkbox"/> CODE C <input type="checkbox"/> OTHER <input type="checkbox"/>		ESTIMATOR RMG		CHECKED BY CEL			
TASK DESCRIPTION		Quantity		LABOR		Cost	EQUIPMENT		MATERIAL		TOTAL		SHIPPING				
		No. Of Units	Unit Meas	MH/ Unit	Total Hrs		Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	Unit Price	
MZ AHU																	
STS		4	EA	1.5	6.0	21.17	85			118	472.00	557					
DTS		3	EA	2.0	6.0	21.17	64			160	480.00	544					
VALVE		2	EA	2.0	4.0	21.17	42			370	740.00	782					
DAMPER		4	EA	1.3	5.2	21.17	85			150	600.00	685					
ST/SP		1	EA	2.0	2.0	21.17	21			66	66.00	87					
FAN DPS		1	EA	2	2.0	21.17	21			59	59.00	80					
WIRE AND CONDUIT		15								\$94.00	\$1,410.00	\$1,410.00					
PROGRAMMING		15					\$2,250.00					\$2,250.00					
SUBTOTAL							\$2,568				\$3,827	\$6,395					
CONTINGENCY		15%					\$385				\$574	\$959					
COST SUB - TOTAL							\$2,953				\$4,401	\$7,354					
OVERHEAD, BOND		15%					\$443				\$660	\$1,103					
PROFIT		10%					\$295				\$440	\$735					
SUBTOTAL							\$3,691				\$5,501	\$9,192					
TOTAL THIS SHEET							\$3,691				\$5,501	\$9,192					

[illegible]

D-1.6.7

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.
DACA 21-91-C-0097

☒ CODE A ☐ CODE B ☐ CODE C
☐ OTHER

EFFECTIVE PRICING
DATE APR. 92
DRAWING NO.

DATE PREPARED
16-Apr-92
SHT OF

CHECKED BY CEL

SHIPPING

ESTIMATOR RMG

TOTAL

MATERIAL

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

LABOR

Quantity

No. Of Units

Unit Meas

MH/ Unit

Total Hrs

Unit Price

Cost

Unit Price

Cost

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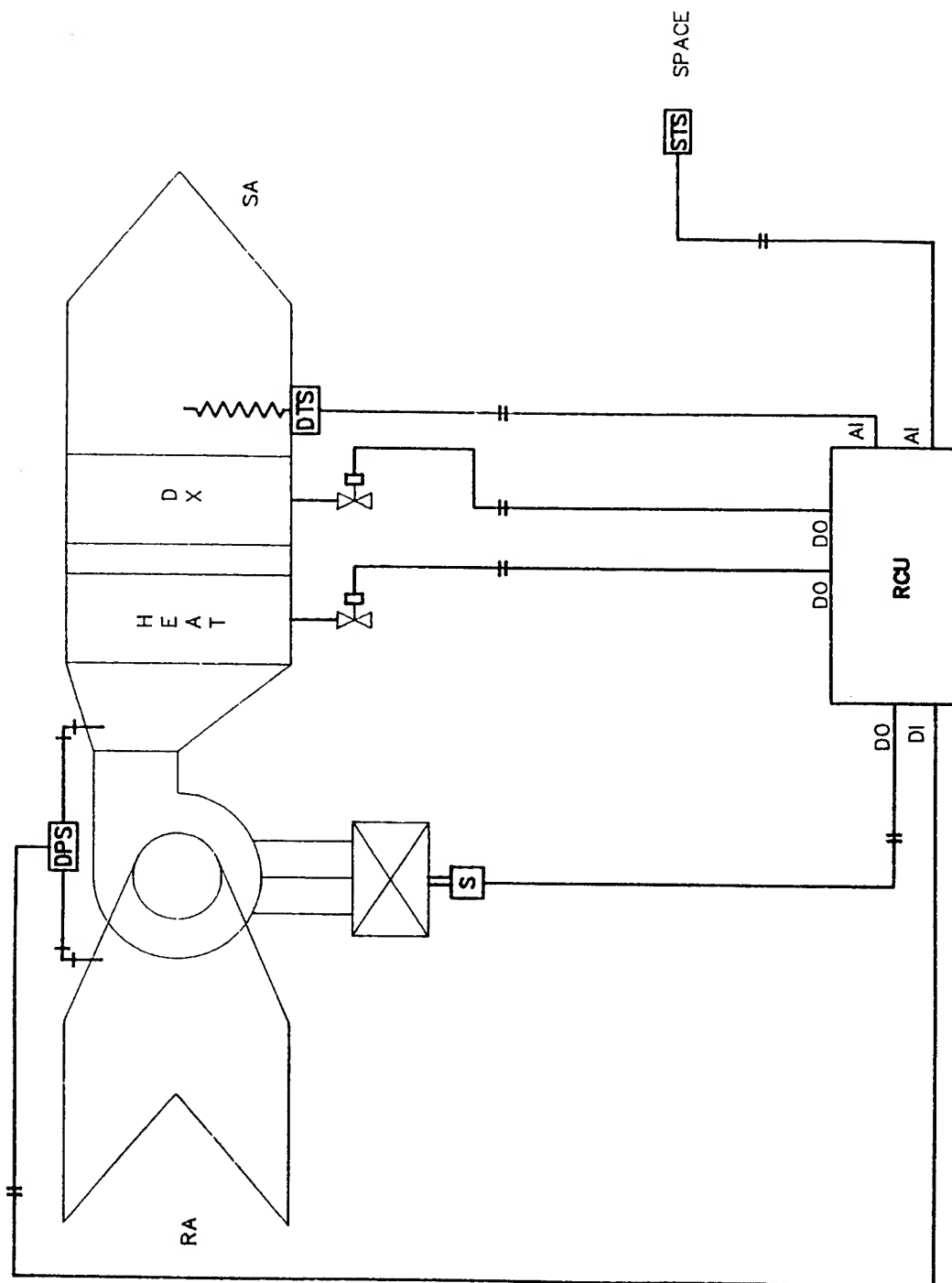
Cost

Unit Price

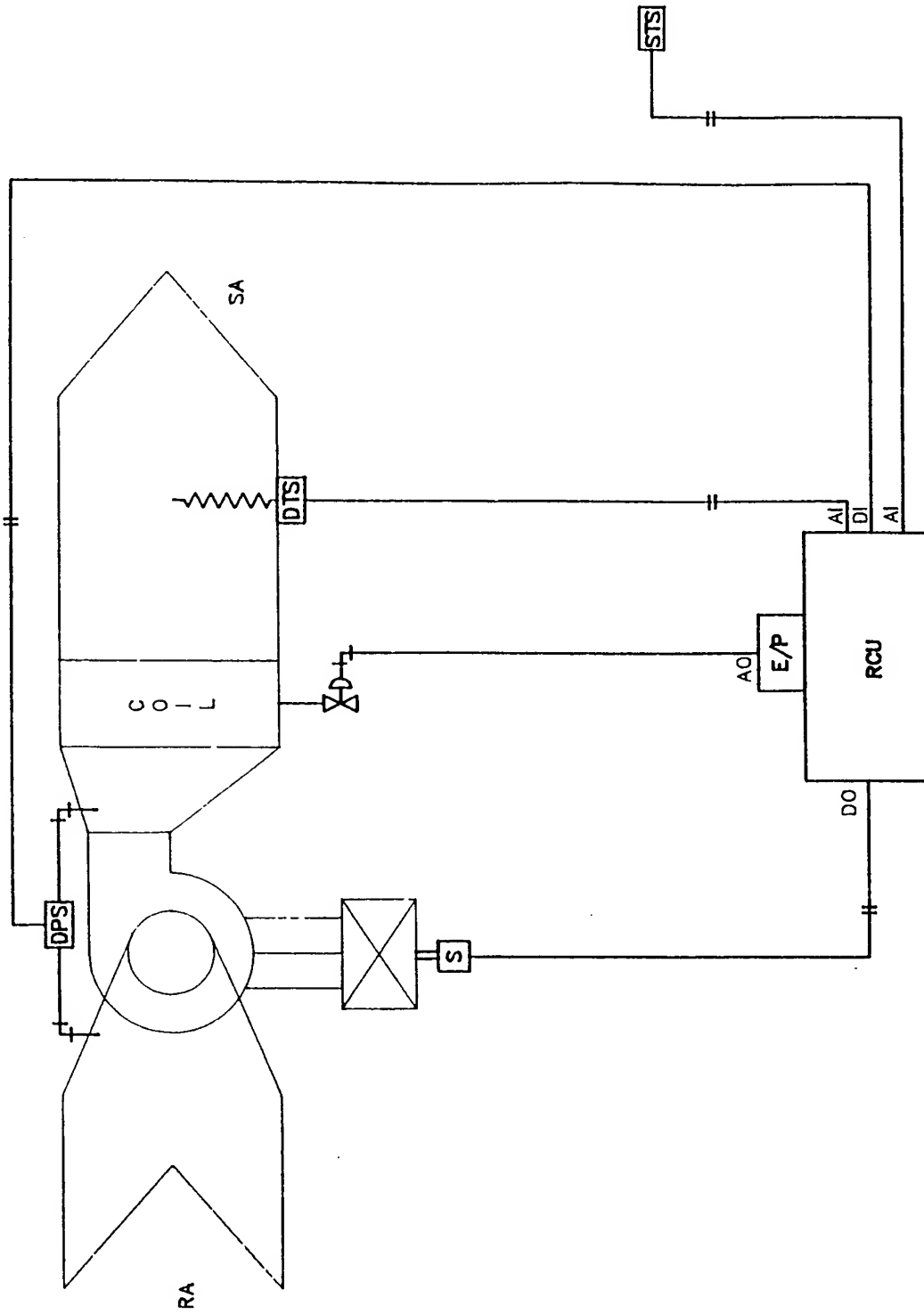
Cost

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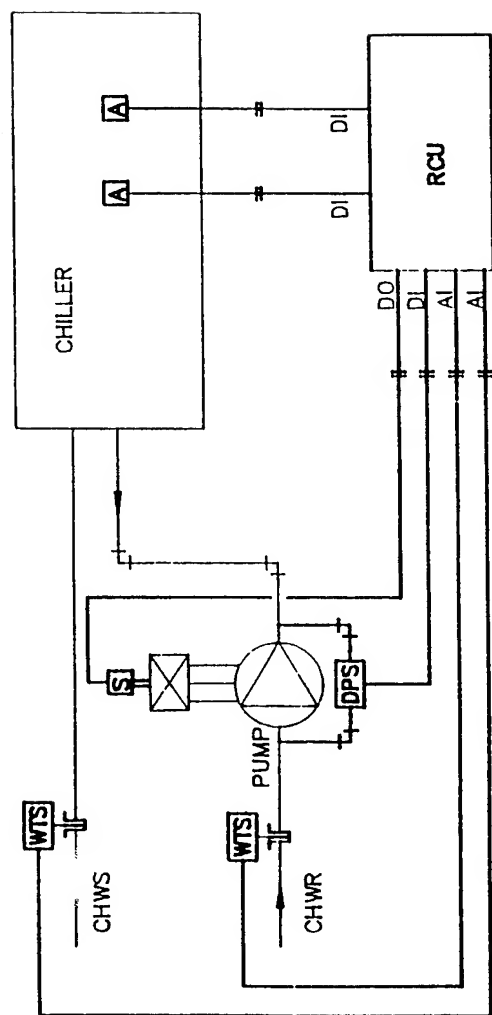
D-1.6.9



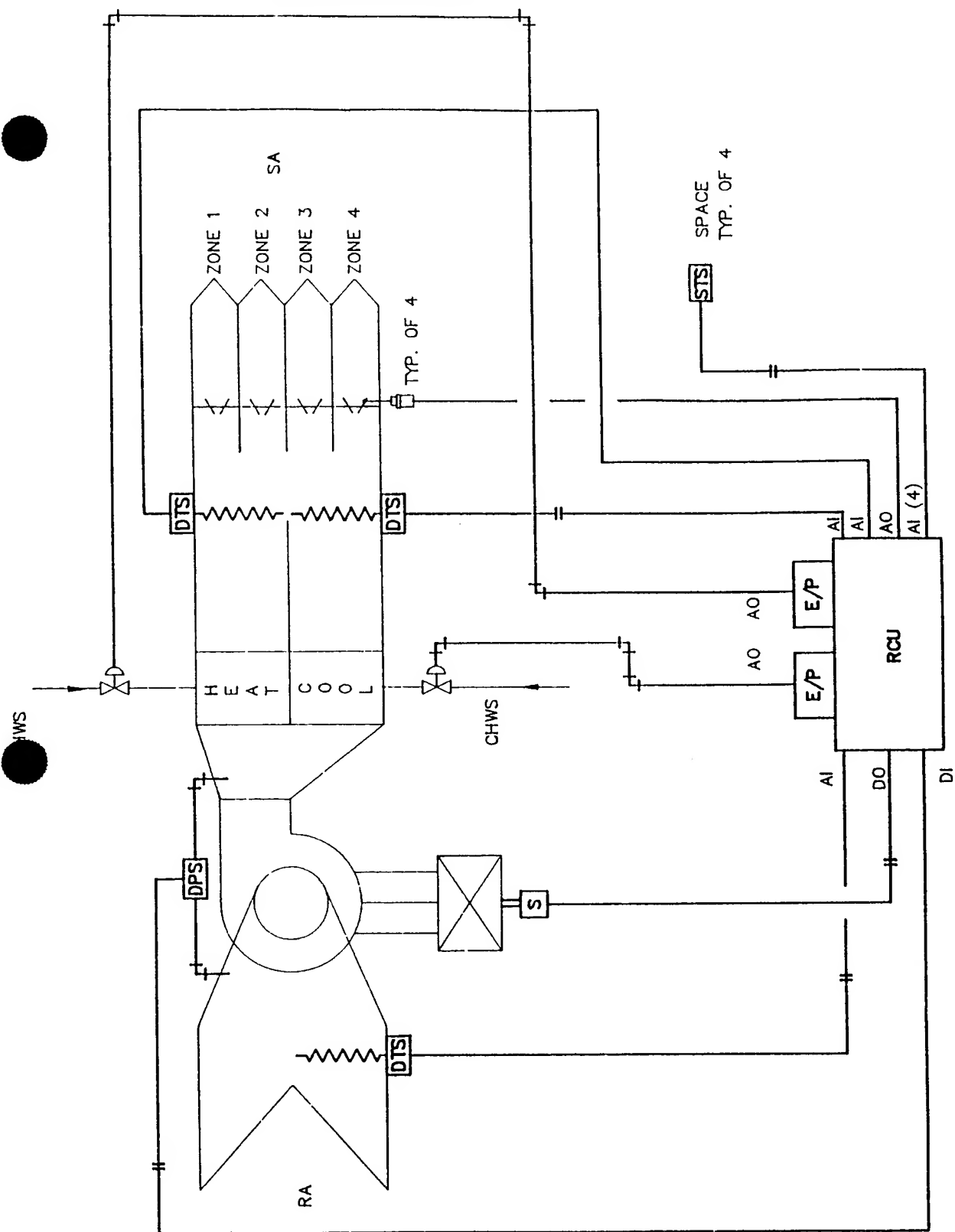
TYPICAL SINGLE ZONE AHU

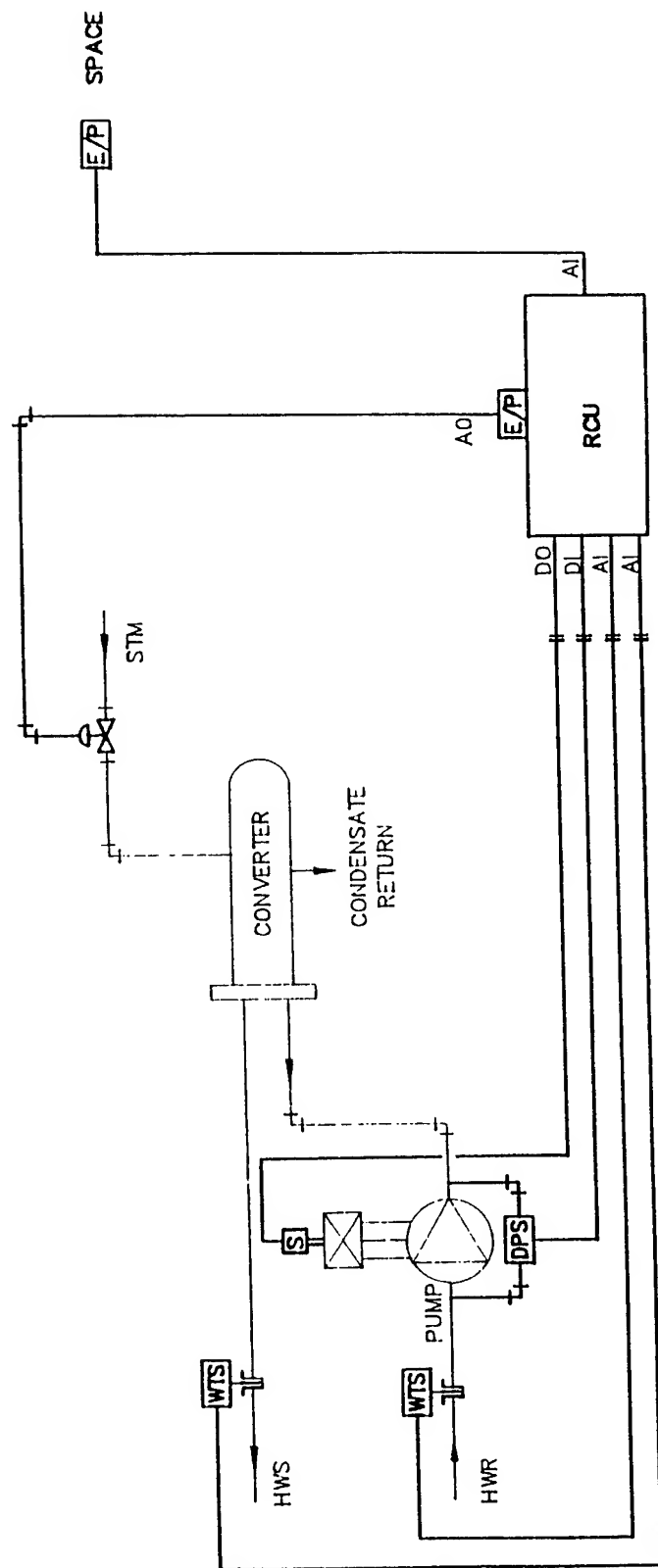


TYPICAL AHU

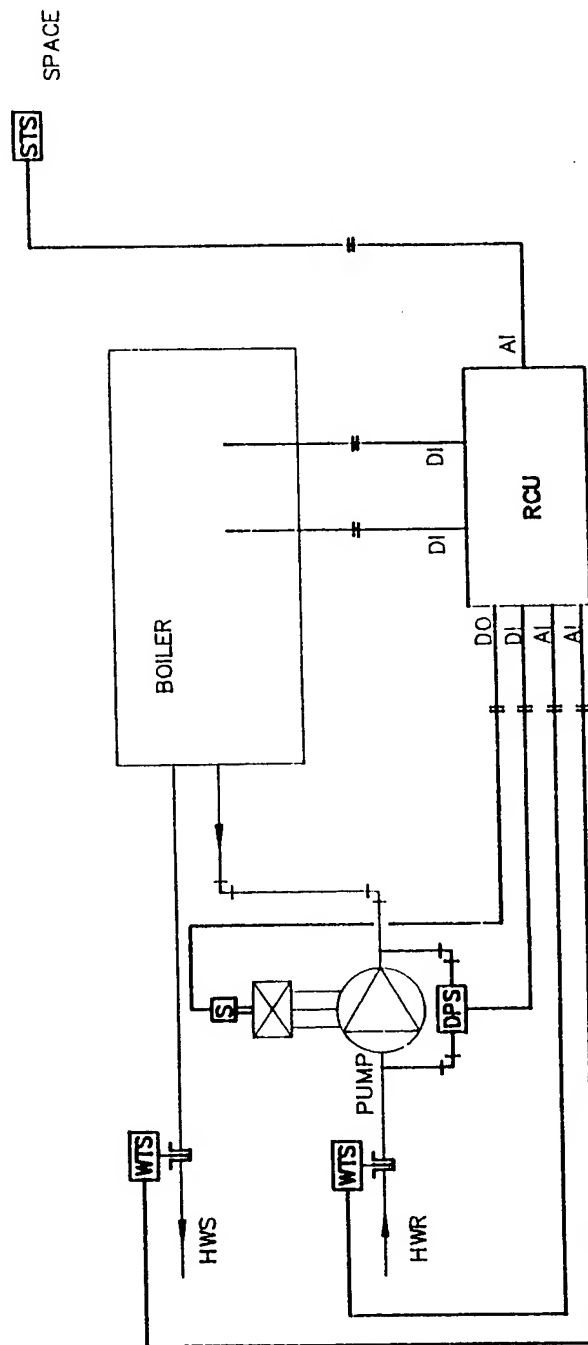


TYPICAL AIR COOLED CHILLER





TYPICAL STM/HW CONVERTER



TYPICAL HW BOILER

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

JOB FT. MCPHERSON/GILLEM ESOS STUDY

EMC#3105.000

SHEET NO _____

OF _____

CALCULATED BY _____

CEL

DATE

7/21/92

CHECKED BY _____

DATE _____

SCALE _____

LABOR SAVINGS:

An estimated 6 hours per year labor (non-energy) savings were taken due to a reduction in temperature (too hot-too cold) related services calls.

(6 hours per year per building) x \$21.16 per hour = \$127 per year per building

ECO-14, RADIANT HEATERS

LIFE CYCLE COST ANALYSIS SUMMARY

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) STUDY: GECO15
 INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 LCCID 1.065
 PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
 FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-14A RADIANT HEAT
 ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	149057.
B. SIOH	\$	8199.
C. DESIGN COST	\$	8944.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	166200.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	899.	\$ 6717.	11.11	74624.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	2007.	\$ 9373.	14.45	135435.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		2906.	\$ 16089.		\$ 210059.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) 10.59

(2) DISCOUNTED SAVING/COST (3A X 3A1) \$ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 69319.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS \text{ ECONOMIC LIFE}))$ \$ 16089.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 210059.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.26
 (IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 10.33

**RADIANT HEAT SAMPLE CALCULATION, ECO #14
BUILDING 512**

Given:

Gas Savings

Analysis based on "Development of Radiant Heating Economic Evaluation Methods," see attached factors page C-14.2.3

$$\begin{aligned}\text{Gas Savings Factor} &= 1,329 \text{ Mbtu per } 149,300 \text{ sq. ft} \\ &= .00890\end{aligned}$$

Electric Savings Factor

Analysis based on computer simulation of building 207, fan electric use, see page C-20.2

$$\begin{aligned}\text{Electric Savings Factor} &= 155,200 \text{ kWh per } 149,3300 \text{ sq. ft} \\ &= 1.04\end{aligned}$$

Demand Savings Factor	= 0.0 kW	
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Peak Demand Savings:

$$(120,327 \text{ ft}^2) * (0.0 \text{ kW} / \text{UA}) = 0.0 \text{ kW}$$

Annual Energy Savings:

$$\begin{aligned}\text{- Gas:} & (120,327 \text{ ft}^2) * (0.0089 \text{ MBtu} / \text{ft}^2) &= 1,071 \text{ MBtu} \\ \text{- Electric:} & (120,327 \text{ ft}^2) * (1.04 \text{ kWh} / \text{ft}^2) &= 125,425 \text{ kWh}\end{aligned}$$

Annual Cost Savings:

$$(1,071.2 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (125,425 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.0 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$8,200 / \text{yr}$$

Estimated Construction Cost:

$$\begin{aligned}& \$0.588 / \text{sq. ft.} \\ & (120,327 \text{ ft}^2 * 0.588) = \$70,786 \\ & \$70,786 + (70,786 * .055 \text{ SIOH}) + (70,786 * .06 \text{ DESIGN}) = \$78,926\end{aligned}$$

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT:
DATE: 09/02/92
FILE: RADIANT WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

#3105.000
09/02/92
RADIANT WK3
DENNIS JONES

ENERGY COST		DISCOUNT FACTOR	SAVINGS FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	14.45 UPWG	0.00792 MBtu/ft2
INCREMENTAL ELECTRIC COST	\$0.0255 kWh	11.11 UPWE	1.03965 kWh/ft2
ELECTRIC DEMAND CHARGE	\$102.66 kW	10.59 UPW	0.00000 kW/ft2
ECONOMIC LIFE 15 YRS			

BUILDING NUMBER	FLOOR AREA (ft2)	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWH)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENE SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
207	149,300	0	155,220	1,183	1,712	9,481	0	0	9,481	97,930	1.3	10.3
400	76,623	0	79,661	607	879	4,866	0	0	4,866	50,259	1.3	10.3
401	27,455	0	28,544	217	315	1,743	0	0	1,743	18,009	1.3	10.3
TOTAL		0	263,425	2,007	2,906	16,090	0	0	16,090	166,198	1.3	10.3

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/02/92
FILE: RADIANT.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:

G207

OPERATIVE TEMPERATURE	TO	65 F
BUILDING LOAD COEFFICIENT	BLC	70,320 Btu/F/hr
AVERAGE HEAT GAIN	Qg(G)	119,860 Btu/hr
CONVENTIONAL SYSTEM EFFICIENCY	Ecc(CEC)	75%
RADIANT EFFICIENCY	RAD	55%
FLOOR AREA	AF	149,300 ft2
RADIANT COMBUSTION EFFICIENCY	Ecr(CER)	85%

MONTH	NUMBER OF DAYS	CONVENTIONAL SYSTEM			RADIANT SYSTEM				HEATING ENERGY SAVINGS (MBtu)	Variable, Equation Column
		BASE -65 DEGREE DAYS (F-day)	OUTSIDE AIR TEMP (F)	C FACTOR	DDm, Eq-12 (F-day)	CORRECTED DEGREE DAYS (F-day)	HEATING ENERGY USAGE (MBtu)	INDOOR AIR TEMP (F)	C FACTOR	
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]
JAN	31	636	47	4	632	1,422	0.184	62	4	554
FEB	28	518	50	4	488	1,098	0.184	63	4	431
MAR	31	428	56	4	357	803	0.184	64	4	322
APR	30	147	65	4	81	182	0.184	65	4	88
MAY	31	25	73	5	0	0	0.184	67	5	0
JUN	30	0	81	5	0	0	0.184	68	5	0
JUL	31	0	82	6	0	0	0.184	68	5	0
AUG	31	0	82	6	0	0	0.184	68	5	0
SEP	30	18	77	5	0	0	0.184	67	5	0
OCT	31	124	67	4	23	52	0.184	66	4	40
NOV	30	417	55	4	375	844	0.184	64	4	337
DEC	31	648	48	4	601	1,353	0.184	63	4	529
YEAR	365	2,961			2,557	5,753				2,302
										4,571
										1,183

JOB EMC #3105.000 Ft. McPherson/Gillem ESOS

E M C ENGINEERS, INC.

Denver • Colorado Springs • Atlanta • Germany

SHEET NO _____ OF _____

CALCULATED BY CEL DATE 9/2/92

CHECKED BY _____ DATE _____

SCALE _____

SAMPLE CALCULATION

Column A: JAN, the month January
 Column B: 31, Nm, number of days in month
 Column C: 636, Degree days based on 65oF (last number in this column is DDa)
 Column D: 47, Outside air temperature oF
 Column E: 4, Correction Factor, C, Equation 13, page C-14.2.5
 Column F: 659, Correct Degree Day base, DDm, Equation 12, page C-14.2.5
 Column G: 1518, Monthly energy consumption, L, Equation 14, page C-14.2.5
 Column H: .184, Radiant factor, M, Equation 17, page C-14.2.7
 Column I: 62, Indoor air temp oF, Ta, Equation 16, page C-14.2.6
 Column J: 4, Correction Factor, C, Equation 13, page C-14.2.5
 Column K: 554, Correct Degree Day base, DDm, Equation 12, page C-14.2.5
 Column L: 1101, Monthly energy consumption, L, Equation 14, page C-14.2.5
 Column M: 321, Savings, column G minus L

[A]	Nm [B]	[C]	Tosa [D]
JAN	31	636	47

C, Eq-13
[E]

$1.339 * (0.00387 * \$DDA - 2.77E - 07 * \$DDA ^ 2) * @EXP(-((\$TO - \$G / \$BLC - D26 + 20) / 16.23) ^ 0.1)$

DDm, Eq-12
[F]

$@MAX(\$B26 * (\$TO - \$G / \$BLC - \$D26 + E26), 0)$

L, Eq-14
[G]

$+\$BLC * F26 * 24 / \$CEC / 1000000$

M, Eq-17
[H]

$+\$RAD / \$AF / 1.22 * (0.35 + 0.35 * 0.64 / 0.58) * \$BLC / \$CER$

Ta, Eq-16

[I]

$+\$TO - (H26 / (H26 + 1)) * (\$TO - D26 - \$G / \$BLC)$

C, Eq-13
[J]

$1.339 * (0.00387 * \$DDA - 2.77E - 07 * \$DDA ^ 2) * @EXP(-((I26 - \$G / \$BLC - D26 + 20) / 16.23) ^ 0.1)$

DDm, Eq-12
[K]

$@MAX(\$B26 * (I26 - \$G / \$BLC - \$D26 + J26), 0)$

L, Eq-14
[L]

$+\$BLC * K26 * 24 / \$CER / 1000000$

[G] - [L]
[M]

$+G26 - L26$

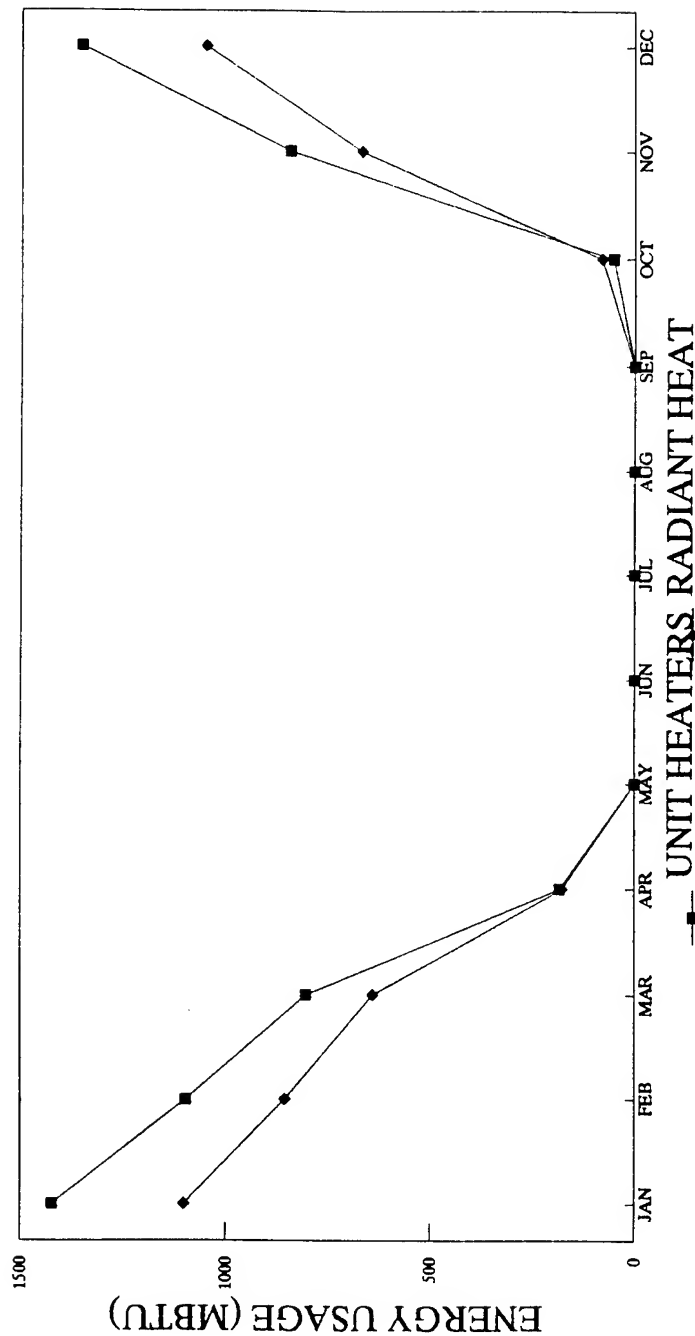
D-1.7.4A

EM C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-14: RADIANT HEAT

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/02/92
FILE: RADIANT.WK3
PREPARED BY: DENNIS JONES
CHECKED BY:



RADIANT HEAT
HEAT LOADS

HOUR	WEEKDAY PROFILE	WEEKEND PROFILE	INTERNAL PEAK LOAD	WEEKDAY HOURLY LOAD	WEEKEND HOURLY LOAD	WEEKLY AVERAGE HOURLY INTERNAL LOADS
1	0.05	0.05	375332	18767	18767	
2	0.05	0.05	375332	18767	18767	
3	0.05	0.05	375332	18767	18767	
4	0.05	0.05	375332	18767	18767	
5	0.05	0.05	375332	18767	18767	
6	0.05	0.05	375332	18767	18767	
7	0.05	0.05	375332	18767	18767	
8	0.8	0.05	375332	300266	18767	
9	1	0.05	375332	375332	18767	
10	1	0.05	375332	375332	18767	
11	1	0.05	375332	375332	18767	
12	0.8	0.05	375332	300266	18767	
13	1	0.05	375332	375332	18767	
14	1	0.05	375332	375332	18767	
15	1	0.05	375332	375332	18767	
16	0.8	0.05	375332	300266	18767	
17	0.8	0.05	375332	300266	18767	
18	0.4	0.05	375332	150133	18767	
19	0.05	0.05	375332	18767	18767	
20	0.05	0.05	375332	18767	18767	
21	0.05	0.05	375332	18767	18767	
22	0.05	0.05	375332	18767	18767	
23	0.05	0.05	375332	18767	18767	
24	0.05	0.05	375332	18767	18767	
AVERAGE				160298	18767	119860

SEE COMPUTER SIMULATION OF BLDG 207 FOR PEAK LOAD AND LOAD PROFILE

BUILDING LOAD COEFICENT 0.471 Btu/sq.ft./hr/oF x 149300 sq.ft. 70320

SEE COMPUTER SIMULATION OF BLDG 207 FOR BLDG HEAT LOSS COEF.

Energy Consumption Calculations

The chief characteristic of radiant heating systems which results in energy savings is the reduction in room air temperatures and a corresponding reduction in envelope heat loss. Additional energy savings are also often the result of an increase in combustion efficiency over conventional heating equipment efficiencies. A simple means for determining heating loads is the variable degree day method [Ref. 8]. The Variable Base Degree Day method was selected due to its simplicity and its compatibility with the mathematical model. The Bin method was also considered, but was rejected since part-load efficiencies for radiant equipment were not available. The only advantage of the Bin method was its ability to consider part-load efficiencies.

Monthly values of degree days at a base temperature of 65°F (18°C) are tabulated for many locations all over the world [Ref. 5, 6]. The base 65°F (18°C) temperature may be corrected to other bases by the following formula [Ref. 4]:

$$DDm = Nm (t_b - t_{osa} + C) , \quad (12)$$

where

DDm = degree days at the new base temperature,

Nm = number of days in the month,

t_b = new base temperature,

t_{osa} = average outside air temperature,

C = correction factor.

The correction factor (C) is given by:

$$C = 1.339(0.00387 DDa - 0.277 \times 10^{-6} DDa^2) \\ \times \exp - [(t_b - t_{osa} + 20^\circ F) / 16.23]^2 , \quad (13)$$

where

DDa = annual base 65°F degree days.

Monthly energy consumption (L) for space heating is:

$$L = BLC \times DDm / E_{cc} , \quad (14)$$

where

BLC = building loss coefficient,

E_{cc} = combustion efficiency of a conventional system.

The BLC is the sum of the individual heat loss factors (component area divided by thermal resistance) for building components plus infiltration/ventilation loads. The following components are generally included:

- Walls
- Ceiling
- Windows
- Doors
- Floor perimeter
- Infiltration/ventilation.

Base temperature (t_b) is calculated as follows:

$$t_b = t_a - Q_g/UA , \quad (15)$$

where Q_g is the energy generated by lights, equipment, occupants, and solar gains.

The heating load for the conventional heating system is then calculated using equation (14) in which degree days is based on the base temperature from equation (15). For conventionally heated buildings, the indoor air temperature (t_a) in equation (15) is equal to the thermostat setpoint.

Radiant Heat Evaluation

The previous study used a computer model to iteratively solve equations (7) through (11) in the order presented. In order to make the model more efficient and to develop nomographs, it was necessary to develop a single equation for performance.

For any given application, equations (7) through (11) will have five unknowns:

- ERF_c = radiant flux from ceiling,
- ERF_f = radiant flux from floor,
- t_a = indoor air temperature,
- t_f = floor temperature,
- Q_R = system energy input.

Solving the five equations simultaneously results in the following expression for indoor air temperature (t_a):

$$t_a = t_b - [M/(M+1)](t_b - t_{osa} - Q_g/BLC) , \quad (16)$$

where

- t_o = desired operative temperature,
- M = radiant factor,
- t_{osa} = outside air temperature,
- Q_g = internal generated heat from lights, people, and equipment,
- BLC = building envelope heat loss factor.

The radiant factor (M) is given by:

$$M = \frac{E_R}{A_F(h_r + h_c)} \left(F_c + \frac{F_F h_r}{h_i} \right) \frac{BLC}{E_{CR}}$$

where

- E_R = radiant efficiency,
- A_F = floor area,
- h_i = total heat transfer coefficient from floor to room,
- F_c = ceiling angle factor,
- F_F = floor angle factor,
- h_r = radiative exchange coefficient of human body,
- E_{CR} = combustion efficiency.

Once indoor air temperature (t_i) is calculated, the remaining unknowns may be calculated from the equations (7) through (10).

The heating load for the radiantly heated building is calculated in two parts; for the floor and for the rest of the building. The floor in a radiantly heated building is maintained at a temperature higher than inside air temperature and thus has a proportionally higher heat loss. For the floor, the base temperature of equation (15) is set at the monthly floor temperature predicted for the radiant system. Heating load of the floor is then the corrected degree days based on floor temperature times the floor loss component of BLC divided by the combustion efficiency.

For the non-floor heating load, the base temperature is calculated from the indoor air temperature predicted for the radiantly heated space. The heating load of the non-floor components is then the corrected degree days times the non-floor components of the

BLC divided by the combustion efficiency. The total radiant heating load is then the sum of floor and non-floor heating loads.

For further information, the following references may be useful.

1. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "Infrared Radiant Heating," ASHRAE Handbook, 1987 Systems and Applications Volume, Chapter 16, Atlanta, Georgia.
2. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "High-Intensity Infrared Heaters," ASHRAE Handbook, 1983 Equipment Volume, Chapter 30, Atlanta, Georgia.
3. Fanger, P.O., Thermal Comfort, McGraw-Hill Book Co., New York, 1973.
4. Lunde, Peter J. "Adjusting Degree Days," Solar Age, November 1982, pp. 57.
5. U.S. Department of the Air Force, the Army, and The Navy, Engineering Weather Data, AFM 88-29/TM 5-785/NAVFAC, p. 89, 1 July 1978.
6. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Local Climatological Data, Annual Summaries for 1984, Parts I-V, May 1985.
7. Wilson, T., and R. Belske, "Movable Insulation Systems," ASHRAE Journal, pp. 26-31, February 1987.
8. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., "Energy Estimating Methods," ASHRAE Handbook, 1985 Fundamentals Volume, Chapter 28, Atlanta, Georgia.
9. "Energy Prices and Discount Factors for Life-Cycle Cost Analysis," NBSIR 85-3273, -2 (Rev. 6/84).
10. "Radiation in Energy Systems," AIAA/ASME 4th Thermophysics and Heat Transfer Conference, Boston, 1986.
11. Tervin, R.R., F.M. Langdon, R.M. Nelson, M.B. Pate. "An Experimental Study of a Multipurpose Commercial Building with Three Different Heating Systems." Dept. of Mechanical Engineering, Iowa State University, May 1986.
12. "Radiant Heat Investigation." USAREUR Contract No. DACA 90-86-D-0054, February 1988.

[illegible]

INVITATION NO./CONTRACT NO.

EFFECTIVE PRICING

DATE PREPARED

DACA 21-91-C-0097

DATE APR 92

22-Apr-92

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

X	CODE A	CODE B	CODE C
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FO SHS

LOCATION Ft. McPherson & Ft Gillem

OTHER _____

Table 1

LOCATION

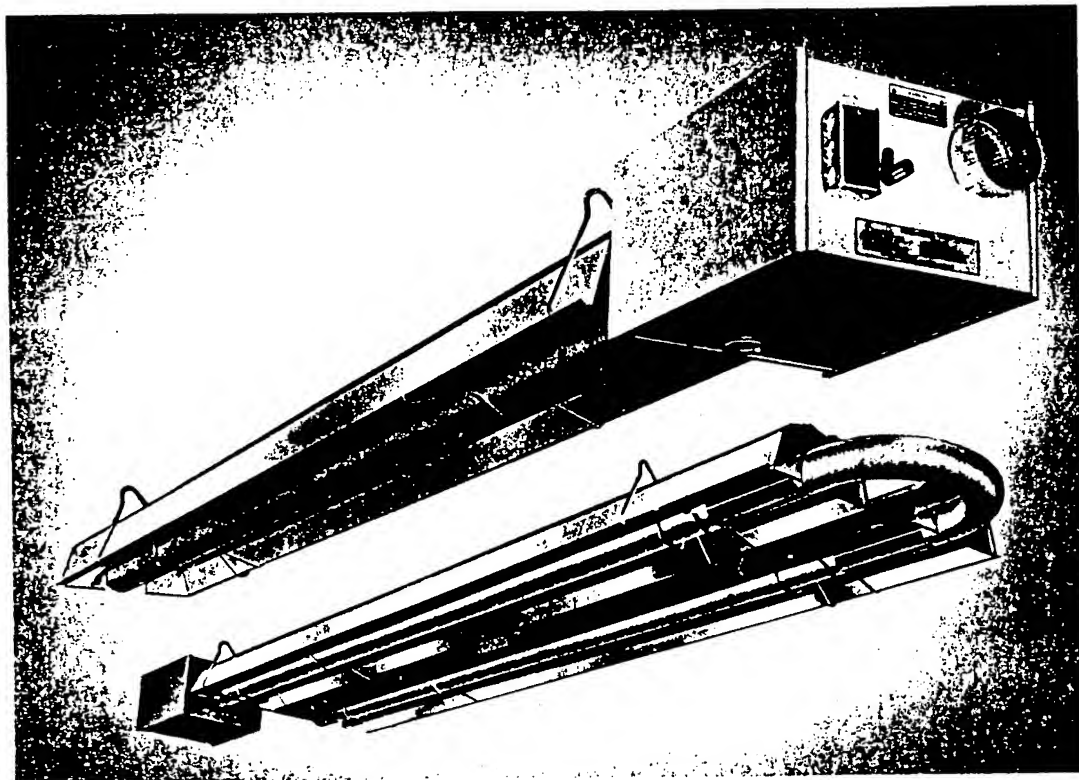
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CHECKED BY CBI

		No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Equipment Unit Price	Material Unit Price	Cost	TOTAL	SHIPPING Unit Wt	Total Wt
RADIANT HEATING TASK DESCRIPTION													
RADIANT HEATER, 150 MBH		20	EA	10	200	\$20.88	\$4,176.00		\$1,000.00	\$20,000.00	\$24,176.00		
FLUE PIPING, 4"		200	LF	0.235	47	\$20.88	\$981.36		\$3.17	\$634.00	\$1,615.36		
ROOF FLASHING, 4"		20	EA	0.471	9.42	\$20.88	\$196.69		\$6.10	\$122.00	\$318.69		
FLUE ELBOW, 4"		20	EA	0.471	9.42	\$20.88	\$196.69		\$7.55	\$151.00	\$347.69		
FLUE TOP, 4"		20	EA	0.364	7.28	\$20.88	\$152.01		\$6.20	\$124.00	\$276.01		
GAS PIPING, 1"		2000	LF	0.151	302	\$20.88	\$6,305.76		\$1.54	\$3,080.00	\$9,385.76		
THERMOSTAT		20	EA	0.615	12.3	\$20.88	\$256.82		\$12.35	\$247.00	\$503.82		
THERMOSTAT WIRE, 2 COND		1000	LF	0.013	12.7	\$20.88	\$266.18		\$0.11	\$110.00	\$375.18		
ELECTRIC SERVICE		300	MSF	2.85	855	\$21.17	\$18,100.35		\$20.00	\$6,000.00	\$24,100.35		
SUBTOTAL							\$30,630.86			\$30,468.00	\$61,098.86		
OVERHEAD, BOND		15%					\$4,594.63			\$4,570.20	\$9,164.83		
PROFIT		10%					\$3,063.09			\$3,046.80	\$6,109.89		
COST SUB - TOTAL							\$38,288.57			\$38,085.00	\$76,373.57		
CONTINGENCY		15%					\$5,743.29			\$5,712.75	\$11,456.04		
TOTAL							\$44,031.85			\$43,797.75	\$87,829.60		

VANTAGE II[®]

*Cost-Saving,
Low-Intensity Infrared
Unitary Heaters*



Roberts-Gordon, Inc.

Energy Efficient Comfort.

VANTAGE II Unitary Heaters

Lower Fuel Costs and Raise Comfort Levels.

Demonstrated Savings

Modern gas combustion technology combined with the principles of infrared energy enable VANTAGE II heaters to reduce fuel costs substantially while improving comfort conditions. Users report heating bills cut by up to 50% and more!

Low Cost...Easy to Install and Maintain

The VANTAGE II models are low-cost, field-assembled infrared heaters that are easy to install and require only minimal maintenance. They are designed to provide years of economical operation and trouble-free service.

Versatility

VANTAGE II heaters can be installed separately or in combination to fit any floor plan. Straight, L- and U-tube configurations are available. Tube lengths are offered from 10 through 60 feet. Ideal for large areas as well as hard-to-heat spaces!

Reliability and Expertise

Roberts-Gordon pioneered low-intensity infrared heating systems in 1962 and manufactures the broadest line of low-intensity heating equipment in North America. Backed by a limited three-year warranty, each VANTAGE II unitary heater is built to uphold the well-established Roberts-Gordon standards of engineering excellence, efficiency and reliability.

Applications Include:

- Automotive Facilities
- Warehouses
- Manufacturing Facilities
- Fire Stations
- Agricultural Buildings
- Recreational Facilities
- Machine Shops
- Aircraft Hangars
- Vehicle Maintenance Buildings



Clean, quiet, draft-free Vantage radiant heat is ideal for this automotive service facility. Unlike forced-air unit heaters, Vantage does not spread dirt, grit or dust.



Vantage unitary heaters are available in a variety of lengths, shapes and configurations to fit any floor plan. Two straight-tube models are shown above in a car dealership.



Floors are kept warm by Vantage infrared energy and act as heat reservoirs to provide rapid heat recovery after bay doors are closed in this warehouse/shipping area.

Features:

- Extensive use of corrosion-resistant materials.
- Weight-saving construction to ease installation.
- Forced draft design eliminates the need for a heat-siphoning draft hood.
- Quiet operation.
- 10 through 60 foot tube lengths.
- Three-year limited warranty on all components.
- A.G.A. design certified.

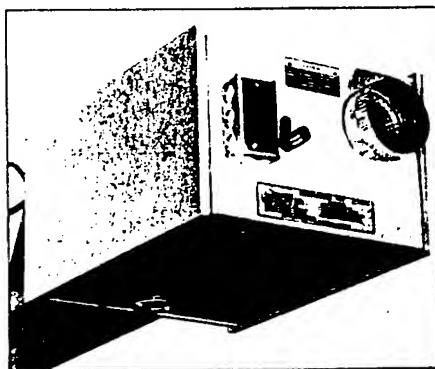
Burner Box:

- 40,000; 60,000; 80,000; 100,000; 125,000 and 150,000 BTU/Hr. models available.
- Natural gas and L.P. models available.
- Moisture-resistant design.
- Stainless steel burner cup.
- Outside air adapter standard.
- Hot surface ignition.
- Three-try ignition module.
- Door interlock safety switch.
- All components easily accessed.
- Electrostatically applied paint.
- Durable spot welded construction.
- Mica flame observation window.
- Balanced air rotor.
- Stainless steel flex gas line and high pressure gas cock included.

Tube and Reflector:

- 4" diameter 16 gauge tubing.
- Quick assembly couplings.
- Deep-dish aluminum reflectors maximize energy reflection, beaming virtually all of the radiant heat downward.
- Reflectors can be tilted 45° to direct heat where needed.
- Entire U-tube heater also can be tilted 45°.
- End caps included.
- Nickel plated hangers.
- Chrome plated hardware.
- Flue connector included.
- 180° U-package (9" radius) option.
- 90° L-package option.
- Decorative grille option.
- Side reflector option.

"The VANTAGE II heater utilizes design concepts and engineering principles proven by more than 25 years of infrared heating experience."



Architectural/Engineering Short Form Specifications VANTAGE II CTH2 SERIES

Gas-fired, vented, infrared heaters shall be furnished and installed in accordance with governing codes and as shown per building drawing(s) as described below.

Heaters shall be VANTAGE II, model number CTH2- _____, _____ BTU/Hr. as manufactured by Roberts-Gordon, Inc., Buffalo, New York.

Heaters shall be equipped with a direct sense silicon-carbide hot surface ignition control system with 100% shut-off ignition device. Power supplied to each heater shall be 120V, 60Hz, 1 ϕ . Heater to be equipped with totally enclosed motor with thermal overload motor protection, balanced air rotor, combustion air proving safety pressure switch, stainless steel burnerhead, combustion chamber equipped with sight glass for visual inspection of igniter element and burner flame. Air intake collar standard. Radiant tube assembly to be 4" diameter, aluminized steel for entire tube length. Hot rolled steel remainder of unit. (Or at customer option, all aluminized steel for entire tube length.) Reflector to be of aluminum material and designed to direct all radiant output below horizontal centerline of radiant tube. Heaters shall be vented in accordance with manufacturer's recommendations and ANSI Z-223.1 National Fuel Gas Code. Heaters shall be so designed to operate without requiring heater modifications or adjustments on _____ gas having a net heating value of _____ BTU per cubic foot and a specific gravity of _____.

Heaters shall be Design Certified by the American Gas Association (A.G.A.). Supplier shall provide a manufacturer's written warranty covering all components for a period of three (3) years.

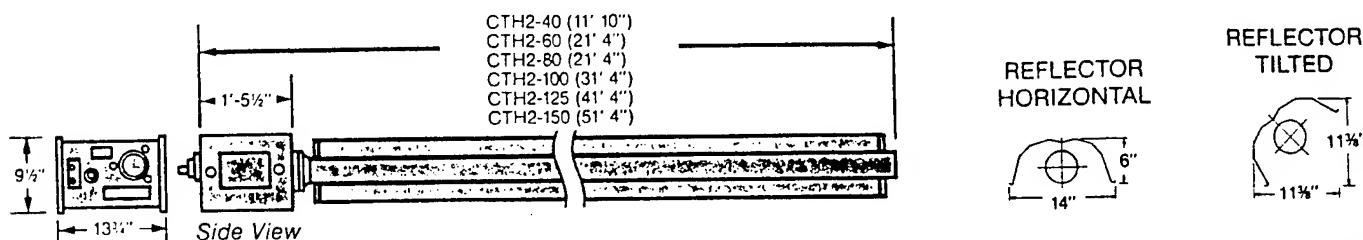
VANTAGE II

CTH2 SERIES SPECIFICATIONS

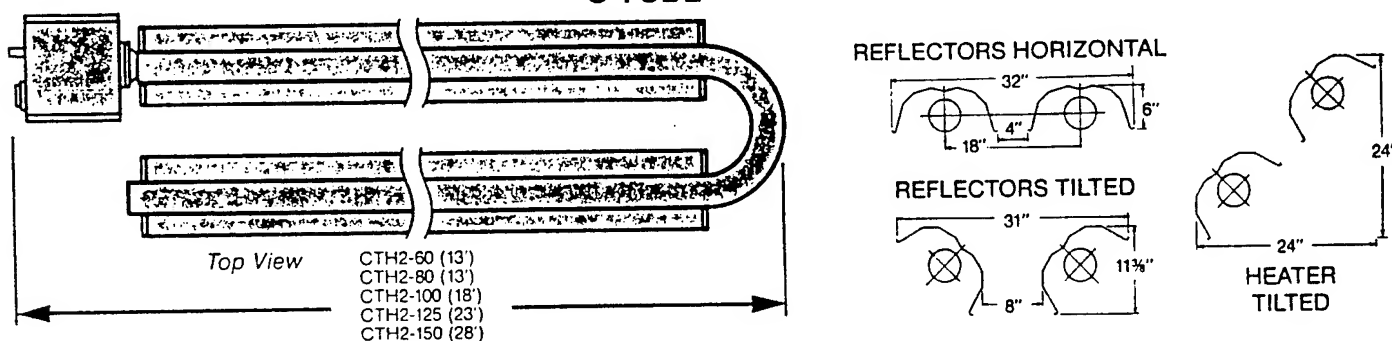
FLUE CONNECTION	GAS CONNECTION	ELECTRICAL RATING	TUBE DIAMETER	IGNITION SYSTEM	MIN. GAS INLET PRES.
4" (O.D.)	1/2" NPT	120VAC, 60Hz. 1.0 amp run 5.0 amp start	4"	Hot surface (Three-try)	Nat. 4.6" W.C. L.P. 11.0" W.C.

MODEL	BTU/Hr. (Natural Gas or L.P.)	SHIPPING WEIGHT	MODEL	BTU/Hr. (Natural Gas or L.P.)	SHIPPING WEIGHT
CTH2-40	40,000	95 lbs.	CTH2-100	100,000	165 lbs.
CTH2-60	60,000	130 lbs.	CTH2-125	125,000	200 lbs.
CTH2-80	80,000	130 lbs.	CTH2-150	150,000	235 lbs.

DIMENSIONS (Standard Models) STRAIGHT



U-TUBE



CLEARANCES TO COMBUSTIBLES*

Configuration	Reflector	CTH2-40			CTH2-60			CTH2-80			CTH2-100			CTH2-125			CTH2-150		
		Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side
Straight	Horizontal	4"	50"	22"	4"	60"	30"	4"	63"	33"	4"	68"	35"	4"	74"	41"	4"	77"	45"
Straight	Tilted	4"	45"	4"/42"	4"	54"	4"/50"	4"	60"	4"/56"	6"	68"	4"/60"	6"	72"	4"/65"	8"	78"	4"/70"
U-Tube	Horizontal	—	—	—	4"	60"	25"/30"	4"	66"	32"/33"	4"	73"	34"/35"	4"	76"	38"/41"	4"	81"	42"/45"
U-Tube	Tilted	—	—	—	4"	54"	18"/50"	4"	60"	18"/56"	6"	68"	18"/60"	6"	72"	18"/66"	8"	78"	18"/70"

Configuration	Heater	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side	Top	Below	Side
U-Tube	Tilted	—	—	—	4"	54"	4"/38"	4"	60"	4"/42"	4"	68"	4"/48"	4"	72"	57"	4"	78"	4"/62"

*See installation manual for complete information.



Roberts-Gordon, Inc.

Subsidiary of A.J. Industries, Inc.

P.O. Box 44 • Buffalo, NY 14240-0044
Phone: (716) 852-4400 • Fax: (716) 852-0854



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IN NEW YORK: 1-800-221-0955

D-1.7.16

Printed in U.S.A.

ECO-15, SEPARATE SWITCHES TO CONTROL LIGHTING

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-15 SEPARATE SWITCHES FOR LIG

ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	26971.
B. SIOH	\$	1484.
C. DESIGN COST	\$	1619.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	30074.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	163.	\$ 1218.	15.61	19014.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	-18.	\$ -82.	23.77	-1954.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		145.	\$ 1136.		\$ 17060.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	1141.
(1) DISCOUNT FACTOR (TABLE A)	14.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	16579.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	16579.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	5630.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E	.75	
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 2277.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 33639.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.12
 (IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.21

**SEPARATE LIGHT SWITCHES SAMPLE CALCULATION, ECO #15
BUILDING 184, ROOM 6**

Given:

# of Fixtures	= 2 fixture	- from survey notes
Fixture Type	= 4x2 4-lamp fluorescent	- from survey notes
Watts / Fixture	= 155 W / fixture	- from manufacturer info
Percent Lighting Savings	= 19%	- average for all bldgs
Hours On / Year	= 3,393 hrs / yr	- from bldg occupancy
Gas Increase Factor	= 5.4E-4 MBtu / kWh	- from computer simulation
Electric Savings Factor	= 0.17 kWh / kWh	- from computer simulation
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Lighting Demand:

$$(2 \text{ fixtures}) * (155 \text{ W / fixture}) = 0.31 \text{ kW}$$

Peak Demand Savings:

$$(0.31 \text{ kW}) * (0.19) = 0.06 \text{ kW}$$

Annual Energy Savings:

Electric:

Lighting:

$$(0.06 \text{ kW}) * (3,393 \text{ hrs / yr}) = 200 \text{ kWh / yr}$$

Cooling:

$$(200 \text{ kWh}) * (0.17 \text{ kWh / kWh}) = 34 \text{ kWh / yr}$$

Total:

$$200 + 34 \text{ kWh / yr} = 234 \text{ kWh / yr}$$

Gas:

$$(200 \text{ kWh / yr}) * (5.4\text{E-}4 \text{ MBtu / kWh}) = 0.1 \text{ MBtu / yr}$$

Annual Cost Savings:

$$(234 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.06 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) - (0.1 \text{ MBtu}) * (\$4.67 / \text{MBtu}) = \$12.08 / \text{yr}$$

Estimated Construction Cost:

\$65.11 / wall sensor - from engineer's cost estimate

$$(\$65.11 / \text{ea}) * (1 \text{ sensor}) = \$65$$

$$\$65 + (\$65 * .055 \text{ SIOH}) + (\$65 * .055 \text{ DESIGN}) = \$72$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO: 15, SEPARATE SWITCHES TO CONTROL LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 07/20/92
FILE: MLTISR.WK3
PREPARED BY: CAMERAN DIBAI
CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	\$0.0255 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.53 UPW

25 YRS

ECONOMIC LIFE
ESTIMATED 8760 HOURS OF LIGHTING PER YEAR

BLDG	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENERG SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
103	0.304	1,702.0	(0.58)	5	\$41	\$31	\$0	\$72	\$436	2.4	6.1
213	2.3	9,316.4	(1.72)	30	\$230	\$236	\$0	\$466	\$3,349	2.1	7.2
935	1.23	6,193.0	(5.80)	15	\$131	\$126	\$0	\$257	\$3,465	1.1	13.5
101	7.28	30,555.0	(9.48)	95	\$735	\$747	\$0	\$1,482	\$22,822	1.0	15.4
TOTAL	11.11	47,766.4	(17.58)	145	\$1,136	\$1,141	\$0	\$2,277	\$30,072	1.1	13.2
400	0.53	1,723	(2.96)	3	\$30	\$54	\$0.00	\$85	\$2,417	0.5	28.6
207	3.17	15,020	(28.50)	23	\$250	\$325	\$0.00	\$575	\$17,634	0.4	30.6
505	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
506	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
507	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
508	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
509	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
510	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
511	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
512	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
513	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
514	0.32	19,718	(8.14)	59	\$465	\$33	\$0.00	\$498	\$29,154	0.3	58.6
401	0	951	(1.60)	2	\$17	\$0	\$0.00	\$17	\$2,208	0.1	131.6

[illegible]

D-1.8.4

PROJECT	Ft. McPherson & Ft. Gillem ESOS Study
LOCATION	Ft. McPherson & Ft. Gillem

DACA 21-91-C-0097

X	CODE A	CODE B	CODE C
	OTHER		

DATE APR 92

30 of LHS

22-Apr-92

DA FORM 5418 - F. APR 85

Passive Infrared Wall Switch

- ♦ Simply replaces existing light switches
- ♦ Large 1000 sq. ft. of coverage
- ♦ Built-in light level sensor
- ♦ Adjustable Sensitivity & Time Delay
- ♦ Advanced transformer/latching relay design
- ♦ Compatible with Electronic Ballasts
- ♦ Proven 30% to 70% savings
- ♦ Available in 24VDC and 24V Half Wave
- ♦ Three-year warranty; UL Listed



System Information

The Watt Stopper WI sensors simply replace existing wall switches and turn lighting systems on only when offices, conference rooms, copy rooms or utility rooms are actually occupied. Lighting systems are automatically turned off after the controlled area is left unoccupied for a user-specified length of time. When the area is used again, the lights are automatically turned on. Savings of 30% to 70% are common.

Sensor Operation

Watt Stopper WI sensors use advanced passive infrared technology to detect occupancy. With a patented, four-level, multiple cell viewing lens, the WI sensors are able to detect the difference between the infrared emissions from a human body and the background space. When no changes in infrared energy are detected for a user specified length of time (adjustable from 30 seconds to 20 minutes), the lighting systems are switched off.

Advanced Light-Level Sensing

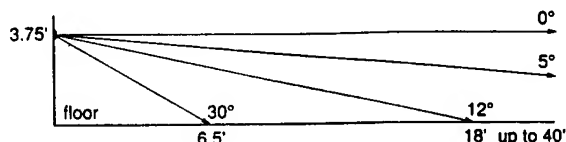
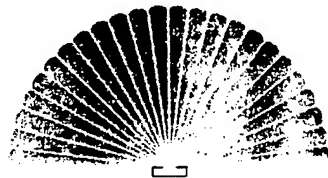
WI-Series sensors also offer integrated light level sensing. Simply put, if the room is unoccupied and lighting systems are OFF, WI-wall switch sensors will not turn all or part of the lighting systems ON if a user-specified level of natural light already exists. A user can simply override this feature by placing his hand over the sensor for a second. This feature will save even more energy in areas with abundant natural light.

Design

WI sensors use a unique transformer and latching-relay system which allows them to work with solid state ballasts and PL lamp systems. They feature a "no-visible screws" low-profile design and an easy OFF/override. For two-gang boxes the WI sensor requires the ASP-111 for blank cover options or the ASP-112 for two level switching.

Applications and Economics

Their expansive 1000 sq. ft. of coverage, adjustable time delay, adjustable sensitivity, advanced viewing lens and built-in light level sensor make WI-series sensors highly configurable and able to handle almost any lighting situation. Due to their competitive price, low installation costs and adjustability, these sensors offer extremely fast payback rates. They are perfect for offices, utility rooms, conference rooms or any area with fluorescent or incandescent lighting systems.



D-1.8.7

WI sensors use a patented viewing lens to cover 180° with a four-level pattern which eliminates mounting height problems and insures accurate detection

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585

WI Sensor Technical Information

WI Sensor Specifications

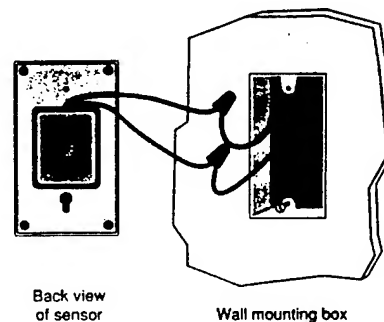
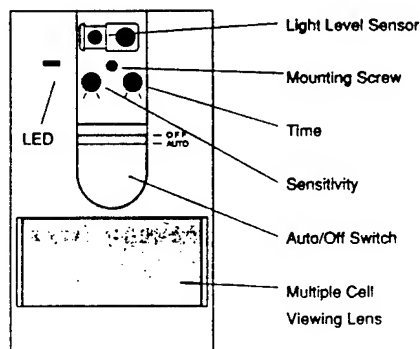
- ♦ Part of a completely integrated line of lighting control products
- ♦ Coverage: covers a 180° area — 40 foot range with adjustment
- ♦ Auto/OFF time delay adjustable from 30 seconds to 20 minutes
- ♦ Adjustable unit sensitivity
- ♦ Integrated light level sensor — works from 5 to 400 footcandles
- ♦ Red LED display to indicate detection
- ♦ Advanced transformer/latching relay design for WI-120A & WI-277A
- ♦ Works with solid-state ballasts and PL type lamps
- ♦ No leakage current in off mode — Patent Pending
- ♦ Small size — 2.8" x 4.8" x 1" (72mm x 122mm x 26mm)
- ♦ Voltage drop protection — Patent Pending
- ♦ Integrated four level fresnel lens — Patent Pending
- ♦ Three-year warranty; UL Listed
- ♦ Available in Tamper Proof Model, and in White or Ivory

Ordering Information

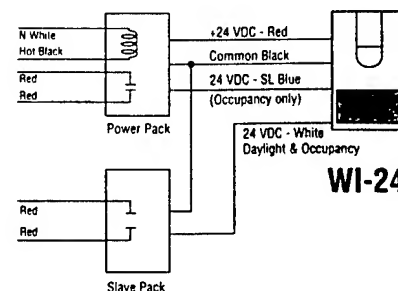
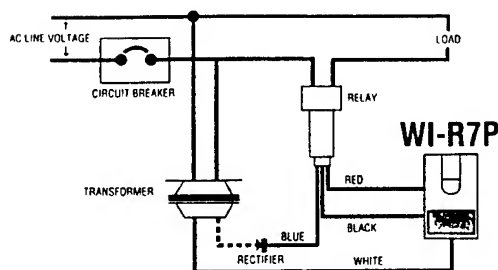
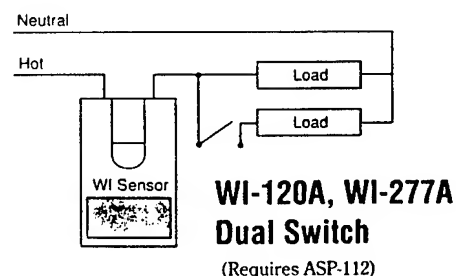
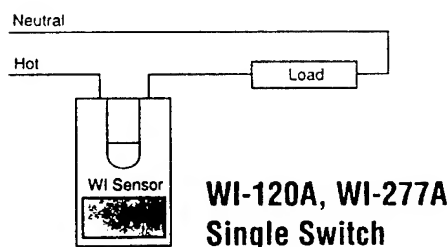
Catalog No.	Coverage	Voltage	Load Requirements	Notes
WI-120A	1000 sq. ft.	120 VAC	50-600 Watts	1
WI-277A	1000 sq. ft.	277 VAC	50-1000 Watts	1
WI-24	1000 sq. ft.	24 VDC	Two 24 VDC outputs	1,2
WI-R7P	1000 sq. ft.	24 VDC halfwave	Three RR7 Relays	1,3
ASP-111	Blank plate for Two Gang Box			1
ASP-112	Switch Plate Cover-Dual Switch			1

Notes: *1 - Add a **TP** to Catalog No. for Tamper Proof, and add a **W** for White or **I** for Ivory
 *2 - Used with Watt Stopper Power Packs
 *3 - For half-wave pulse, low-voltage lighting systems

Product Controls and Installation



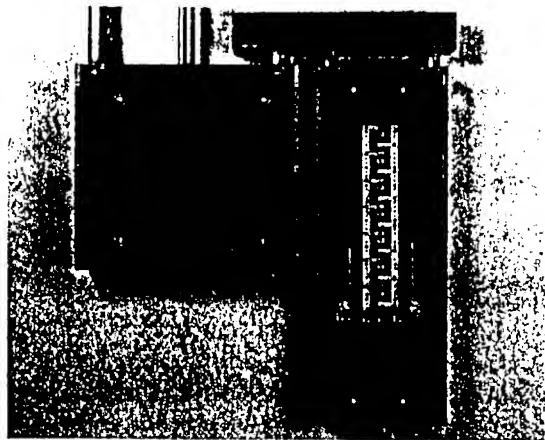
Circuit Schematics



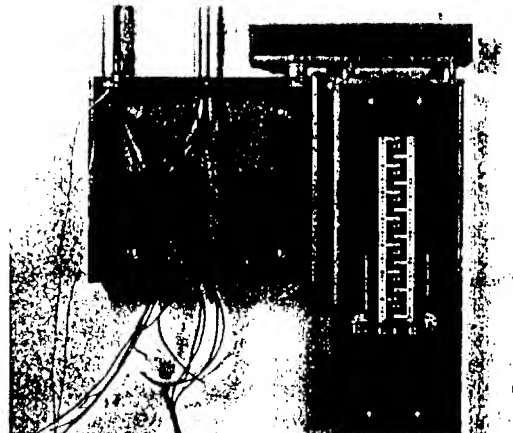
The Watt Stopper, Inc.
 Santa Clara, CA 95050
 Pub. No. 0302

TLC LAP Installation

Mount Tub



Mount the tub next to the lighting distribution panel.



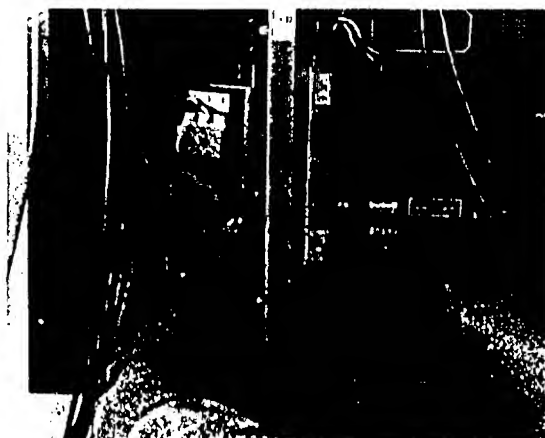
Run line voltage wiring from circuit breaker to tub and switched circuits from tub to areas.

Mount Interior

Install Power Supply

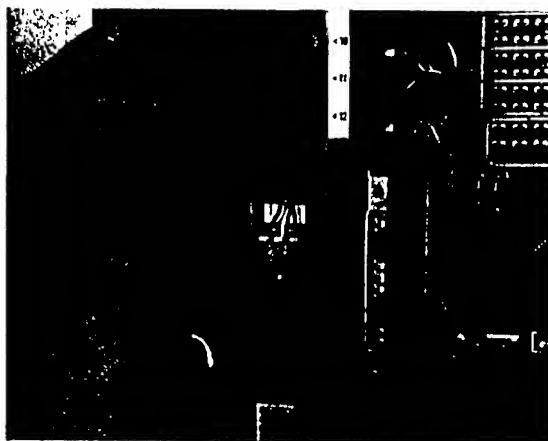


Slide the interior into the tub and secure.

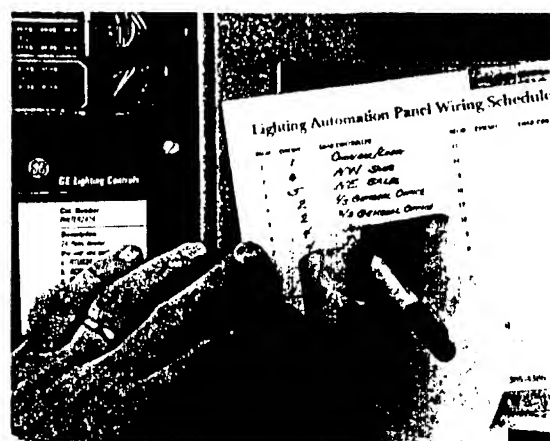


Mount the power supply to the interior and plug in.

Connect Line Voltage Wiring



Connect line voltage wiring to the relays and power supply.

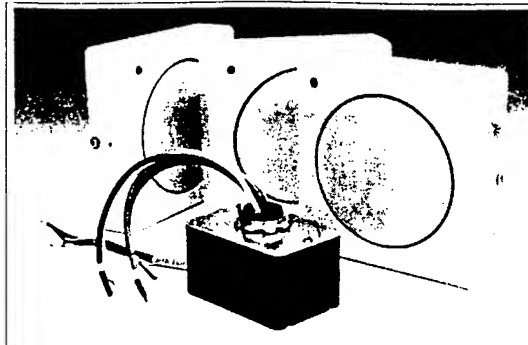


Install cover. Record all connections on the Wiring Schedule Card on the rear of the cover. Power up.

All lighting in the area is now under TLC relay control. Proceed to add direct switches and occupancy sensors.

Ultrasonic Sensors

- ◆ Proven 30% to 60% savings; Turn lights on only when needed
- ◆ 500, 1000 and 2000 sq. ft. coverages available
- ◆ Adjustable sensitivity & time delay
- ◆ Fully-integrated product line
- ◆ UL Listed; Three-year warranty



Complete Systems Integration

Operation

Features

Applications

Economics

Watt Stopper Ultrasonic Sensors are part of an integrated system of lighting control products. Sensors are available to control almost any application, and can work as stand-alone products or as part of a larger lighting control system.

Watt Stopper Ultrasonic Sensors utilize advanced omni-directional ultrasonic doppler technology to sense occupancy. When ceiling mount sensors detect movement in controlled areas, they switch lighting systems on through a Watt Stopper Power Pack. The sensor controls the power pack through low-voltage wiring. As long as movement is sensed, the lights remain on. Lighting systems are switched off when no movement is detected in a user-adjustable period of time (from 15 seconds to 15 minutes).

Watt Stopper Ultrasonic Sensors are designed to work across a wide variety of applications, both individually and as part of a larger system. All Watt Stopper Ultrasonic sensors feature adjustable time delay (from 15 seconds to 15 minutes), adjustable sensitivity, logic key/ON bypass and omni-directional ultrasonic technology. An LED indicator makes sensitivity adjustments easier. In addition, Watt Stopper Ultrasonic sensors are UL Listed and have a three-year warranty.

Ultrasonic sensors come in coverages of 500 sq. ft., 1000 sq. ft. and 2000 sq. ft. They're designed to work together to effectively control small offices, utility areas, open office spaces and even warehouses. The W-500A is perfect for offices, conference rooms, bathrooms and other areas up to 500 sq. ft. The W-1000A is ideal for larger spaces like classrooms and storage areas. The W-2000H is ideal for hallways, while the W-2000A is ideal for large open areas such as warehouses and can control partitioned open office spaces when configured in highly-versatile zone patterns. The W-120C and W-277C are wall switch replacement units that are ideal for small storage areas, bathrooms and enclosed rooms. All the units are designed to pick up people reaching for phones, writing, typing, etc.

Watt Stopper Ultrasonic Sensors slash utility costs by turning lights off when they're not needed. And, unlike sweep systems, they don't impair the work environment in any way. Also, easy installation and low initial cost provide fast paybacks.

- ◆ Solid State, crystal-controlled (25 KHZ \pm .005)
- ◆ Omni-directional transmission (360° coverage)
- ◆ Temperature and humidity-resistant 25 KHZ Microphone Receivers
- ◆ Logic Key/ON bypass
- ◆ 4.5" x 4.5" x 1.25" (115mm x 115mm x 32mm) (W x L x D)
- ◆ Available in White or Ivory

The Watt Stopper, Inc.
Santa Clara, CA 95050
TEL: (408) 988-5331
FAX: (408) 988-5373
Plano, TX 75023
1-800-879-8585

Ultrasonic Sensor Technical

Ordering Information

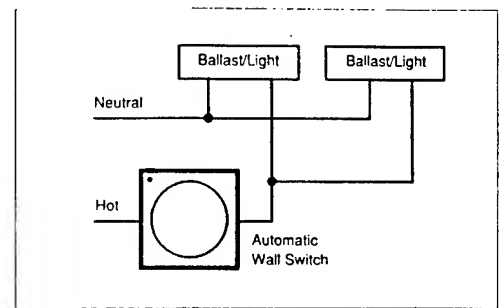
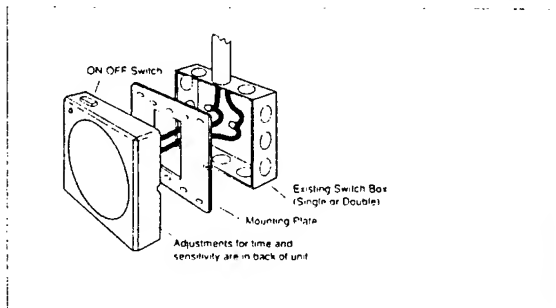
Catalog No.	Description/Type	Voltage	Current/Load	Coverage	Load Requirements
W-120C	Wall Switch	120 VAC	150-800 Watts	500 sq.ft. - 180°	
W-277C	Wall Switch	277 VAC	150-1000 Watts	500 sq.ft. - 180°	
W-500A	Ceiling Sensor	24 VDC	20 ma	500 sq.ft. - 360°	1, 2*
W-1000A	Ceiling Sensor	24 VDC	20 ma	1000 sq.ft. - 360°	1, 2*
W-2000A	Ceiling Sensor	24 VDC	20 ma	2000 sq.ft. - 360°	1, 2*
W-2000H	Hallway Sensor	24 VDC	20 mA	1000 sq.ft. **	1, 2*

*1 - Used with Watt Stopper Power Packs.

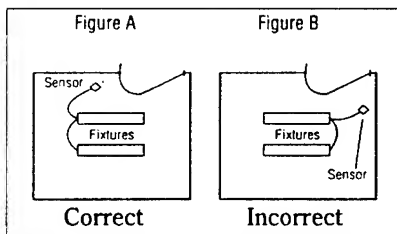
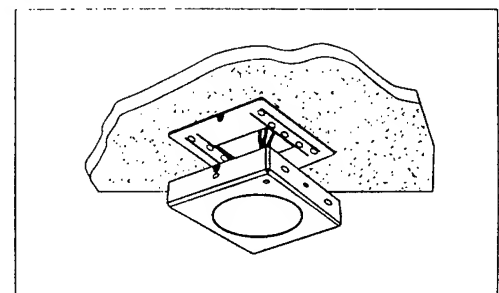
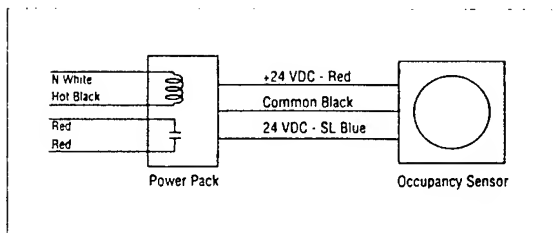
*2 - Available for Half-wave pulse, low-voltage lighting systems. Add "-24" to Catalog No.

Note: Standard models are White, add an I to Catalog No. for Ivory.

Wall Switch Placement and Schematic

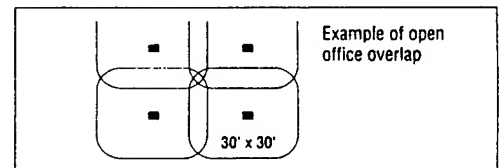


Ceiling Sensor Placement and Schematic

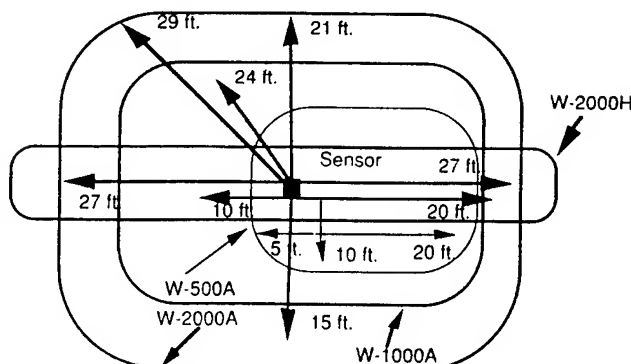


For enclosed spaces sensors should be placed as in Figure A. Sensors placed as in Figure B would see out the door, resulting in false triggering.

For standard installation use toggle bolts attaching mounting plate to ceiling tile. Always try to attach sensor to a vibration free surface.



Ceiling Sensor Coverage



For open office space the W-2000A is the most often used because of its true 360° coverage and capability to bounce off of partitions, walls, floors and other reflecting objects to sense motion. A typical layout for open office space is for the ultrasonic sensors to control the office area in zones that overlap. The coverage can be for a 20' x 20' zone and up to a maximum of 40' x 40'. A typical zone is about 25' x 25' for the lighting fixtures and an overlap on the sensor coverage that picks up to 30' x 30'.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000

DATE: 22-Apr-92

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

EXIT SIGNS: 70

BUILDING NUMBER: 101

Sheet 1 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
218	17	4x2-4 lamp fluorescent	on	yes	no	2	no
220	12	8'-2 lamp fluorescent	on	yes	no	2	yes
222	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
223	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
225	18	4x2-4 lamp fluorescent	off	yes	no	4	no
227	10	4x2-4 lamp fluorescent	on	yes	no	1	no
228	16	4x2-4 lamp fluorescent	on	yes	no	3	no
229	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
230	2	4x2-2 lamp fluorescent	off	yes	no	1	no
232	1	4x2-4 lamp fluorescent	off	yes	no	1	no
236	4	4x2-4 lamp fluorescent	on	yes	no	1	no
336	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
339	5	4x2-4 lamp fluorescent	on	yes	no	1	no
341	2	4x2-4 lamp fluorescent	on	yes	no	1	no
343	2	4x2-4 lamp fluorescent	on	yes	no	1	no
342	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
345	3	4x2-4 lamp fluorescent	on	no	yes	0	yes
201	64	4x2-4 lamp fluorescent	on	yes	no	12	no
204	3	4x2-4 lamp fluorescent	on	yes	no	1	no
207	3	4x2-4 lamp fluorescent	on	yes	no	1	no
209	3	4x2-4 lamp fluorescent	on	yes	no	1	no
210	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
211	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
212	1	4x2-4 lamp fluorescent	on	no	no	0	yes
213	11	4x2-4 lamp fluorescent	on	yes	no	3	yes
214	14	4x2-4 lamp fluorescent	on	yes	no	3	no
215	2	4x2-4 lamp fluorescent	on	no	no	0	yes
216	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
433	2	60 Watt Incandescent	off	yes	no	1	yes
301	1	4x2-4 lamp fluorescent	off	yes	no	1	no
303	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
305	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
307	16	4x2-4 lamp fluorescent	on	yes	no	2	no
311	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
312	3	4x2-4 lamp fluorescent	on	yes	no	1	no
316	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
317	5	4x2-4 lamp fluorescent	on	yes	no	1	no
320	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
322	1	4x2-4 lamp fluorescent	off	yes	no	1	no
324	1	8'-2 lamp fluorescent	off	no	no	0	no
328	1	8'-2 lamp fluorescent	off	no	no	0	no
330	68	4x2-4 lamp fluorescent	on	yes	no	17	no
332	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
334	1	4x2-2 lamp fluorescent	on	yes	no	1	no
401	25	4x2-4 lamp fluorescent	on	yes	no	6	no
403	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
405	3	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 2 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
407	1	75 Watt Incandescent	off	yes	no	1	no
409	7	4x2-4 lamp fluorescent	on	yes	no	1	no
411	5	2x2-2 U-Bulb fluorescent	on	yes	no	2	no
413	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
414	4	4x2-4 lamp fluorescent	off	yes	yes	1	no
416	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
419	2	60 Watt Incandescent	off	yes	no	1	no
422	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
423	2	8'-2 lamp fluorescent	off	no	yes	0	no
425	1	8'-2 lamp fluorescent	off	yes	no	1	no
427	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
429	47	4x2-4 lamp fluorescent	on	yes	no	12	no
252	6	4x2-4 lamp fluorescent	on	yes	no	3	yes
253	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
254	1	60 Watt Incandescent	off	yes	no	1	no
233	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
234	9	4x2-4 lamp fluorescent	on	yes	no	2	no
235	3	4x2-4 lamp fluorescent	on	yes	no	1	no
237	16	4x2-4 lamp fluorescent	on	yes	no	2	no
238	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
239	5	4x2-4 lamp fluorescent	on	yes	no	2	yes
240	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
241	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
242	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
243	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
244	1	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
245	1	60 Watt Incandescent	off	yes	no	1	no
246	3	4x2-4 lamp fluorescent	on	yes	no	1	no
247	3	4x2-4 lamp fluorescent	on	yes	no	1	no
248	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
249	3	4x2-4 lamp fluorescent	on	yes	no	1	no
250	8	4x2-4 lamp fluorescent	on	yes	no	2	no
251	5	4x2-4 lamp fluorescent	on	yes	no	1	no
333	9	4x2-4 lamp fluorescent	on	yes	no	3	no
335	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
337	5	4x2-4 lamp fluorescent	on	yes	no	1	no
338	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
340	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
344	2	4x2-4 lamp fluorescent	on	no	no	0	yes
200	5	4x2-4 lamp fluorescent	on	yes	no	1	no
202	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
203	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
205	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
206	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
217	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
219	63	4x2-4 lamp fluorescent	on	yes	no	8	no
221	1	60 Watt Incandescent	off	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 3 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
224	4	4x2-4 lamp fluorescent	on	yes	no	1	no
226	8	4x2-4 lamp fluorescent	on	yes	no	2	no
231	7	4x2-4 lamp fluorescent	on	yes	no	2	no
300	5	4x2-4 lamp fluorescent	on	yes	no	2	no
302	6	4x2-4 lamp fluorescent	on	yes	no	1	no
304	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
306	9	4x2-4 lamp fluorescent	on	yes	no	2	no
307	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
308	98	4x2-4 lamp fluorescent	on	yes	no	8	no
310	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
314	10	4x2-4 lamp fluorescent	on	yes	no	2	no
313	6	4x2-4 lamp fluorescent	on	yes	yes	1	yes
318	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
321	1	4x2-4 lamp fluorescent	on	yes	no	1	yes
323	85	4x2-4 lamp fluorescent	on	yes	no	10	no
325	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
326	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
327	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
329	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
331	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
400	6	8'-2 lamp fluorescent	on	yes	no	2	no
402	10	4x2-4 lamp fluorescent	on	yes	no	2	no
406	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
404	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
408	2	8'-2 lamp fluorescent	off	yes	no	1	no
408	1	4x2-2 lamp fluorescent	off	yes	no	1	no
410	8	4x2-4 lamp fluorescent	on	yes	no	1	no
412	48	4x2-4 lamp fluorescent	on	yes	no	5	no
420	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
421	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
424	1	200 Watt Incandescent	off	no	yes	0	no
426	5	4x2-4 lamp fluorescent	on	yes	no	1	no
428	8	4x2-4 lamp fluorescent	off	yes	yes	1	no
428	3	2x2-2 U-Bulb fluorescent	off	yes	yes	1	no
430	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
431	3	4x2-2 lamp fluorescent	on	yes	no	1	no
432	3	4x2-2 lamp fluorescent	on	yes	no	1	no
39	1	150 Watt Incandescent	on	yes	yes	1	yes
25	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
24	18	4x2-4 lamp fluorescent	on	yes	no	7	no
26	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
23	8	4x2-4 lamp fluorescent	on	yes	yes	1	no
22	9	4x2-4 lamp fluorescent	on	yes	no	1	no
46	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
46A	1	150 Watt Incandescent	on	yes	yes	1	yes
75	8	4x2-4 lamp fluorescent	on	yes	no	1	no
74	8	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT GILLEM

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 4 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
74A	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
73A	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
73	10	4x2-4 lamp fluorescent	on	yes	no	1	no
72	4	4x2-4 lamp fluorescent	off	yes	no	1	no
71	12	4x2-4 lamp fluorescent	on	yes	no	1	no
HALL-1	8	4x2-4 lamp fluorescent	on	yes	no	2	no
67	2	8'-2 lamp fluorescent	off	yes	no	1	no
70	2	4x2-4 lamp fluorescent	on	yes	no	1	no
69	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
61	6	4x2-4 lamp fluorescent	on	yes	no	2	no
68	1	8'-2 lamp fluorescent	on	yes	no	1	no
59	1	150 Watt Incandescent	off	yes	no	1	no
59	2	4x2-2 lamp fluorescent	off	yes	no	1	no
60	2	4x2-4 lamp fluorescent	off	yes	no	1	no
21	20	4x2-4 lamp fluorescent	on	yes	no	2	no
58	6	4x2-4 lamp fluorescent	on	yes	no	1	no
57A	1	4x2-4 lamp fluorescent	off	yes	no	1	no
57	1	4x2-2 lamp fluorescent	off	yes	no	1	no
56	2	4x2-4 lamp fluorescent	off	yes	no	1	no
54	3	4x2-4 lamp fluorescent	on	yes	no	1	no
55	3	4x2-4 lamp fluorescent	off	yes	yes	1	no
53	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
53A	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
53B	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
51	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
52	1	4x2-4 lamp fluorescent	on	no	yes	0	no
50	3	4x2-4 lamp fluorescent	on	no	yes	0	yes
49	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
48	12	4x2-4 lamp fluorescent	on	yes	no	2	yes
47	6	4x2-4 lamp fluorescent	off	yes	yes	1	no
45	2	8'-2 lamp fluorescent	off	yes	yes	1	no
45	2	4x2-2 lamp fluorescent	off	yes	yes	1	no
44	1	150 Watt Incandescent	on	yes	no	1	yes
43	1	150 Watt Incandescent	on	yes	no	1	yes
34	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
71	12	4x2-4 lamp fluorescent	on	yes	no	1	no
68	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
61	8	4x2-2 lamp fluorescent	on	yes	no	2	no
60	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
59	1	150 Watt Incandescent	on	yes	yes	1	no
59	2	4x2-2 lamp fluorescent	on	yes	yes	1	no
21	20	Single lamp fluorescent	on	yes	no	1	no
21	10	Single lamp fluorescent	off	yes	no	1	no
40	2	Single lamp fluorescent	on	yes	yes	1	yes
41	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
27	12	Single lamp fluorescent	on	yes	no	1	yes
27A	2	4x2-2 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION: FORT GILLEM

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: G101LITE.WK3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 101

Sheet 5 of 5

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
28	3	4x2-2 lamp fluorescent	on	yes	no	1	yes
8	8	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
2A	4	4x2-4 lamp fluorescent	on	no	yes	0	yes
2C	4	4x2-4 lamp fluorescent	on	no	yes	0	yes
2B	8	4x2-4 lamp fluorescent	on	no	yes	0	yes
5A	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
5B	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
6	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
3A	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
3B	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
19	3	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
13	52	12V-75W HALOGEN	off	yes	no	1	no
14	3	8'-2 lamp fluorescent	off	yes	no	1	no
14A	1	4x2-4 lamp fluorescent	off	yes	no	1	no
20	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
16	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
15	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
14B	2	4x2-4 lamp fluorescent	off	yes	no	1	no
65A	8	4x2-4 lamp fluorescent	off	no	yes	0	yes
65B	6	4x2-4 lamp fluorescent	on	no	no	0	yes
65C	8	4x2-4 lamp fluorescent	off	no	no	1	no
65D	12	4x2-4 lamp fluorescent	on	yes	no	1	no
76	1	4x2-4 lamp fluorescent	off	yes	no	1	no
86	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
88A	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
88	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
77	8	4x2-4 lamp fluorescent	on	yes	yes	1	yes
85	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
88	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
87	1	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
87	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
78	4	4x2-4 lamp fluorescent	off	yes	yes	2	no
79	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
80	5	4x2-4 lamp fluorescent	on	yes	yes	1	no
81	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
82	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
84	1	4x2-4 lamp fluorescent	off	yes	yes	1	no
83	8	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 1 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
218	2.64	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
220	2.52	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
222	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
223	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
225	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
227	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
228	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
229	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
230	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
232	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
236	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
336	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
339	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
341	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
343	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
342	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
345	0.47	3915	0.09	121	0.044	140	1	\$396.17	YES	\$65.11	NO	\$0.00
201	9.92	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
204	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
207	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
209	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
210	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
211	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
212	0.16	3915	0.00	40	0.015	47	1	\$396.17	NO	\$0.00	NO	\$0.00
213	1.71	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
214	2.17	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
215	0.31	3915	0.00	81	0.029	93	1	\$396.17	NO	\$0.00	NO	\$0.00
216	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
433	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
301	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
303	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
305	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
307	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
311	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
312	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
316	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
317	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
320	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.00
322	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
324	0.21	3915	0.00	55	0.020	63	1	\$396.17	NO	\$0.00	NO	\$0.00
328	0.21	3915	0.00	55	0.020	63	1	\$396.17	NO	\$0.00	NO	\$0.00
330	10.54	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
332	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
334	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
401	3.88	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
403	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
405	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
				2607.841						\$455.77		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

0:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 2 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
407	0.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
409	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
411	0.46	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
413	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
414	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
416	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
419	0.12	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
422	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
423	0.42	3915	0.08	109	0.039	127	1	\$396.17	YES	\$65.11	NO	\$0.00
425	0.21	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
427	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
429	7.29	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
252	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
253	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
254	0.06	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
233	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
234	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
235	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
237	2.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
238	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
239	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
240	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
241	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
242	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
243	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
244	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
245	0.06	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
246	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
247	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
248	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
249	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
250	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
251	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
333	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
335	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
337	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
338	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
340	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
344	0.31	3915	0.00	81	0.029	93	1	\$396.17	NO	\$0.00	NO	\$0.00
200	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
202	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
203	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
205	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
206	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$0.00	YES	\$372.00
217	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
219	9.77	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
221	0.06	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				3533.406						\$585.99		

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 3 of 5

% Unnoc. lights: 19%

Gas Increase Factor 3.60E-04 MBtu/kWh

Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
224	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
226	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
231	1.08	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
300	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
302	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
304	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
306	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
307	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
308	15.19	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
310	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
314	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
313	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
318	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
321	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
323	13.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
325	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
326	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
327	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
329	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
331	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
400	1.26	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
402	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
406	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
404	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$372.00
408	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
408	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$372.00
410	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
412	7.44	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
420	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
421	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
424	0.20	3915	0.04	52	0.019	60	1	\$0.00	YES	\$65.11	NO	\$0.00
426	0.78	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
428	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$0.00
428	0.28	3915	0.05	205	0.074	238	0	\$0.00	YES	\$65.11	NO	\$0.00
430	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
431	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
432	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
25	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
24	2.79	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
26	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$0.00
23	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$0.00
22	1.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$0.00
46A	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				7991.855						\$976.65		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

0:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY: CEL

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 4 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
74A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
73A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
73	1.55	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
72	0.62	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
HALL-1	1.24	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	0.42	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
69	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
61	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.21	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	3.10	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
57	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
56	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
54	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
55	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
53	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
53A	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
53B	0.47	3915	0.09	346	0.125	401	0	\$0.00	YES	\$65.11	NO	\$0.00
51	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
52	0.16	3915	0.03	40	0.015	47	1	\$396.17	YES	\$65.11	NO	\$0.00
50	0.47	3915	0.09	121	0.044	140	1	\$396.17	YES	\$65.11	NO	\$0.00
49	0.47	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
48	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
47	0.93	3915	0.18	692	0.249	802	0	\$0.00	NO	\$0.00	YES	\$372.00
45	0.42	3915	0.08	312	0.112	362	0	\$0.00	YES	\$65.11	NO	\$0.00
45	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
44	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
43	0.15	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
34	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
71	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
68	0.21	3915	0.04	156	0.056	181	0	\$0.00	YES	\$65.11	NO	\$0.00
61	0.71	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
60	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
59	0.15	3915	0.03	112	0.040	129	0	\$0.00	YES	\$65.11	NO	\$0.00
59	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
21	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
40	0.08	3915	0.02	60	0.021	69	0	\$0.00	YES	\$65.11	NO	\$0.00
41	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
27	0.48	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27A	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				4755.218						\$976.65		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: G101LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 101

Sheet 5 of 5

% Unnoc. lights: 19%
Gas Increase Factor 3.60E-04 MBtu/kWh
Cooling Factor (Energy) 1.16

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
28	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.74	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2A	0.62	3915	0.12	161	0.058	187	1	\$396.17	NO	\$0.00	YES	\$372.00
2C	0.62	3915	0.12	161	0.058	187	1	\$396.17	NO	\$0.00	YES	\$372.00
2B	1.24	3915	0.24	322	0.116	374	2	\$792.34	NO	\$0.00	YES	\$372.00
5A	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
5B	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
3A	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$0.00	YES	\$372.00
3B	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
19	0.28	3915	0.05	205	0.074	238	0	\$0.00	YES	\$65.11	NO	\$0.00
13	3.90	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.63	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14A	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
20	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.00
15	0.31	3915	0.06	231	0.083	267	0	\$0.00	YES	\$65.11	NO	\$0.00
14B	0.31	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65A	1.24	3915	0.24	322	0.116	374	2	\$792.34	NO	\$0.00	YES	\$372.00
65B	0.93	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65C	1.24	3915	0.00	322	0.116	374	2	\$792.34	NO	\$0.00	NO	\$0.00
65D	1.86	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
76	0.16	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
86	0.27	3915	0.05	199	0.071	230	0	\$0.00	YES	\$65.11	NO	\$0.00
88A	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
88	0.18	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$372.00
85	0.09	3915	0.02	66	0.024	77	0	\$0.00	YES	\$65.11	NO	\$0.00
88	0.21	3915	0.04	156	0.056	181	0	\$0.00	YES	\$65.11	NO	\$0.00
87	0.09	3915	0.02	68	0.025	79	0	\$0.00	YES	\$65.11	NO	\$0.00
87	0.18	3915	0.03	132	0.048	154	0	\$0.00	YES	\$65.11	NO	\$0.00
78	0.62	3915	0.12	461	0.166	535	0	\$0.00	NO	\$0.00	YES	\$372.00
79	0.31	3915	0.06	81	0.029	93	1	\$396.17	YES	\$65.11	NO	\$0.00
80	0.78	3915	0.15	576	0.208	669	0	\$0.00	NO	\$0.00	YES	\$372.00
81	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
82	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
84	0.16	3915	0.03	115	0.042	134	0	\$0.00	YES	\$65.11	NO	\$0.00
83	1.24	3915	0.24	922	0.332	1070	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	211.910		7.2751	26340.24	9.48	30555	19	\$7,131.06		\$4,036.82		\$9,300.00
Total \$ Expense = \$20,467.88												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 21-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 103LITE.WK3

PREPARED BY: JW

CLIENT CONTRACT NO: DACA21-91-C-0097

CHECKED BY: CEL

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 9

BUILDING NUMBER: 103

Sheet 1 of 1

Schedule #1 M-F 600 to 1900 S-S 600 to 1900
Schedule #2 M-F 0 to 2400 S-S 0 to 2400

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	1	4x2-4 lamp fluorescent	on	yes	yes	1	yes
2	4	4x2-2 lamp fluorescent	off	yes	no	2	no
3	2	4x2-2 lamp fluorescent	on	yes	no	1	yes
4	1	4x2-2 lamp fluorescent	off	yes	no	1	no
5A	1	150 Watt Incandescent	off	yes	yes	1	no
5B	1	150 Watt Incandescent	off	yes	no	1	no
6	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
7	1	150 Watt Incandescent	on	yes	no	1	yes
8	5	8'-2 lamp fluorescent	on	yes	no	4	yes
9	5	4x2-2 lamp fluorescent	off	yes	no	2	no
10	1	120 Watt Incandescent	on	yes	no	1	no
10	1	4x2-2 lamp fluorescent	on	yes	no	1	no
12	2	4x2-2 lamp fluorescent	off	yes	no	1	no
13	1	4x2-2 lamp fluorescent	off	yes	no	1	yes
14	1	8'-2 lamp fluorescent	on	yes	yes	1	yes
15	20	4x2-2 lamp fluorescent	on	yes	no	3	no
15	4	8'-2 lamp fluorescent	on	yes	no	2	yes
16	1	4x2-2 lamp fluorescent	on	yes	no	1	yes
17	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
18	1	75 Watt Incandescent	on	yes	no	1	yes
19	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
20	4	4x2-2 lamp fluorescent	on	yes	no	1	no
21	1	75 Watt Incandescent	off	yes	no	1	yes

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 21-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 103LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 103

Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 4.00E-04 MBtu/kWh
Cooling Factor (Energy) 1.18

							Cost of Switches					
Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	0.16	4745	0.03	140	0.056	165	0	\$0.00	YES	\$65.11	NO	\$0.00
2	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	0.18	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
5A	0.15	4745	0.03	135	0.054	160	0	\$0.00	YES	\$65.11	NO	\$0.00
5B	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
6	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00
7	0.15	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	1.05	8760	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.45	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.12	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.18	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.21	4745	0.04	189	0.076	223	0	\$0.00	YES	\$65.11	NO	\$0.00
15	1.78	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
15	0.84	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.09	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.47	4745	0.09	419	0.168	495	0	\$0.00	YES	\$65.11	NO	\$0.00
18	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.31	4745	0.06	279	0.112	330	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.36	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.08	4745	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Total	7.709		0.304	1442.48	0.58	1702.126	0	\$0.00		\$390.66		\$0.00
Total \$ Expense =							\$390.66					

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 40

BUILDING NUMBER: 213

Sheet 1 of 3

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
7	8	4x2-2 lamp fluorescent	on	yes	no	1	no
24	4	4x2-4 lamp fluorescent	on	yes	no	1	no
24	8	4x2-2 lamp fluorescent	on	yes	no	1	no
8	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
12	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
11	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
10	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
Reception	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
7	12	4x2-4 lamp fluorescent	on	yes	no	2	no
8	2	4x2-4 lamp fluorescent	on	yes	no	1	no
9	3	4x2-4 lamp fluorescent	on	yes	no	1	no
13	5	4x2-4 lamp fluorescent	on	yes	no	1	yes
11	6	4x2-2 lamp fluorescent	on	yes	no	1	no
12	6	4x2-2 lamp fluorescent	on	yes	no	1	no
17	6	4x2-4 lamp fluorescent	on	yes	no	1	no
21	3	4x2-4 lamp fluorescent	on	yes	no	1	no
23	2	4x2-2 lamp fluorescent	off	yes	no	1	no
19	1	4x2-2 lamp fluorescent	off	yes	yes	1	no
20	3	4x2-4 lamp fluorescent	on	yes	no	1	no
22	2	4x2-2 lamp fluorescent	off	yes	no	1	no
67	11	4x2-4 lamp fluorescent	on	yes	no	2	no
70	2	4x2-2 lamp fluorescent	on	yes	no	1	no
77	4	4x2-2 lamp fluorescent	on	yes	no	1	yes
77	9	4x2-2 lamp fluorescent	on	yes	no	1	yes
71	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
72	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
73	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
75	8	4x2-4 lamp fluorescent	on	yes	no	1	yes
74	2	4x2-2 lamp fluorescent	on	yes	yes	1	yes
76	19	4x2-2 lamp fluorescent	on	yes	no	1	yes
Photolab	14	4x2-2 lamp fluorescent	on	yes	no	2	no
93	4	4x2-4 lamp fluorescent	off	yes	no	1	no
96	1	4x2-4 lamp fluorescent	off	yes	no	1	no
97	1	4x2-4 lamp fluorescent	off	yes	no	1	no
Microlab	1	4x2-4 lamp fluorescent	off	yes	no	1	no
98	2	4x2-4 lamp fluorescent	off	yes	no	1	no
100	16	4x2-4 lamp fluorescent	on	yes	no	4	no
35	1	4x2-2 lamp fluorescent	off	yes	no	1	no
Chem.Rm	1	4x2-4 lamp fluorescent	on	yes	no	1	no
91	2	4x2-4 lamp fluorescent	on	yes	no	1	no
79	2	4x2-4 lamp fluorescent	on	yes	no	1	no
78	3	4x2-4 lamp fluorescent	on	yes	no	2	no
108	4	4x2-4 lamp fluorescent	on	yes	no	2	no
107	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
109	2	4x2-4 lamp fluorescent	off	yes	no	1	no
110	3	4x2-4 lamp fluorescent	on	yes	no	1	no
106	2	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: 213LITE.wk3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 213

Sheet 2 of 3

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Lights	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
104	2	4x2-4 lamp fluorescent	on	yes	no	1	no
102	2	4x2-4 lamp fluorescent	on	yes	no	1	no
101	1	4x2-2 lamp fluorescent	on	yes	no	1	no
105	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
64	20	4x2-4 lamp fluorescent	on	yes	no	1	no
59	5	4x2-4 lamp fluorescent	off	yes	no	1	no
Footwear	3	4x2-4 lamp fluorescent	off	yes	no	1	no
Laser Rm	3	4x2-4 lamp fluorescent	off	yes	no	1	no
Auto Rm	6	200 Watt Incandescent	off	yes	no	1	no
111	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
111	3	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
113	4	2x2-2 U-Bulb fluorescent	off	yes	yes	1	no
114	4	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
116	4	2x2-2 U-Bulb fluorescent	on	yes	no	1	no
117	20	4x2-4 lamp fluorescent	on	yes	no	2	yes
117	8	2x2-2 U-Bulb fluorescent	on	yes	no	2	yes
119	3	8'-2 lamp fluorescent	on	yes	no	1	no
121	9	4x2-4 lamp fluorescent	on	yes	no	1	no
122	6	2x2-2 U-Bulb fluorescent	on	yes	no	1	no
123	21	8'-2 lamp fluorescent	on	yes	no	5	no
125	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
125	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	yes
127	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
127	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	yes
128	3	8'-2 lamp fluorescent	off	yes	no	1	no
129	5	8'-2 lamp fluorescent	on	yes	no	6	yes
129	12	4x2-2 lamp fluorescent	on	yes	no	6	yes
103	3	4x2-4 lamp fluorescent	on	yes	yes	1	yes
104	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
102	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
105	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
108	12	4x2-4 lamp fluorescent	on	yes	no	2	no
109	6	4x2-4 lamp fluorescent	off	yes	no	2	no
110	10	4x2-2 lamp fluorescent	off	yes	no	1	no
112	10	4x2-4 lamp fluorescent	on	yes	no	2	no
115	14	4x2-4 lamp fluorescent	on	yes	no	2	no
115	2	2x2-2 U-Bulb fluorescent	on	yes	no	2	no
118	4	2x2-2 U-Bulb fluorescent	on	yes	yes	1	no
120	9	4x2-4 lamp fluorescent	on	yes	no	2	no
124	14	4x2-4 lamp fluorescent	on	yes	no	1	no
126	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
129	32	4x2-4 lamp fluorescent	on	yes	no	1	no
58	4	2x2-2 U-Bulb fluorescent	on	yes	no	1	yes
56	4	4x2-4 lamp fluorescent	on	yes	no	1	no
55	2	4x2-4 lamp fluorescent	on	yes	no	1	no
Clean-up	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
62	4	4x2-4 lamp fluorescent	on	yes	no	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY
LOCATION:

ECO: 15-LIGHTING CONTROL

CLIENT CONTRACT NO: DACA21-9-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 22-Apr-92

FILE: 213LITE.wk3
PREPARED BY: JW
CHECKED BY: CEL

BUILDING NUMBER: 213

Sheet 3 of 3

Schedule #1 M-F 600 to 1900 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
52	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
51	16	4x2-4 lamp fluorescent	on	yes	no	3	no
65	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
66	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
45	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
48	48	4x2-4 lamp fluorescent	on	yes	no	2	no
48	22	4x2-2 lamp fluorescent	on	yes	no	2	no
42	28	4x2-4 lamp fluorescent	on	yes	no	1	no
42	6	4x2-2 lamp fluorescent	on	yes	no	1	no
79	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
27	13	4x2-4 lamp fluorescent	on	yes	no	2	no
30	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
86	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
34	4	4x2-4 lamp fluorescent	on	yes	no	1	yes
37	6	4x2-4 lamp fluorescent	off	yes	no	1	no
38	6	4x2-4 lamp fluorescent	on	yes	yes	1	no
39	2	2x2-2 U-Bulb fluorescent	on	yes	yes	1	yes
94	235	4x2-2 lamp fluorescent	on	yes	no	1	no
95	4	4x2-4 lamp fluorescent	on	yes	yes	1	yes
96	1	4x2-2 lamp fluorescent	on	yes	yes	1	yes
97	5	4x2-4 lamp fluorescent	on	yes	no	2	yes
98	7	4x2-2 lamp fluorescent	off	yes	no	1	no
99	12	4x2-4 lamp fluorescent	on	yes	no	5	no
99	1	2x2-2 U-Bulb fluorescent	off	yes	no	2	no
100	1	2x2-2 U-Bulb fluorescent	off	yes	no	1	no
101	1	4x2-2 lamp fluorescent	off	yes	no	1	no
102	4	4x2-4 lamp fluorescent	on	yes	no	2	yes
106	10	4x2-4 lamp fluorescent	on	yes	no	2	no
107	2	4x2-4 lamp fluorescent	on	yes	no	1	yes
66	2	4x2-4 lamp fluorescent	off	yes	no	1	no
46	3	4x2-4 lamp fluorescent	on	yes	no	1	yes
47	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
71	2	4x2-4 lamp fluorescent	on	yes	no	1	no
72	2	4x2-4 lamp fluorescent	off	yes	no	1	no
73	1	4x2-4 lamp fluorescent	off	yes	no	1	no
41	14	4x2-4 lamp fluorescent	on	yes	no	2	no
39	23	4x2-4 lamp fluorescent	on	yes	no	2	no
77	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
32	6	4x2-4 lamp fluorescent	on	yes	yes	2	yes
26	2	4x2-4 lamp fluorescent	on	yes	yes	1	yes
25	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
28	2	4x2-4 lamp fluorescent	on	yes	yes	1	no
29	3	4x2-4 lamp fluorescent	on	yes	yes	1	no
33	3	4x2-4 lamp fluorescent	on	yes	no	1	no
35	2	4x2-4 lamp fluorescent	off	yes	yes	1	no
90	5	4x2-4 lamp fluorescent	on	yes	no	1	no
36	2	4x2-4 lamp fluorescent	off	yes	yes	1	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY:

JW

CHECKED BY:

CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 213

Sheet 1 of 3

% Unnoc. lights: 19%

Gas Increase Factor 2.20E-04 MBtu/kWh

Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
7	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
24	0.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
12	0.27	3393	0.05	172	0.038	205	0	\$0.00	YES	\$65.11	NO	\$0.00
11	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
10	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
Reception	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
7	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
8	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
9	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
13	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
11	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
12	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
21	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
23	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
19	0.09	3393	0.02	57	0.013	68	0	\$0.00	YES	\$65.11	NO	\$0.00
20	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
22	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
67	1.71	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
70	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.36	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	0.80	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
71	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
72	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
73	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
75	1.24	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
74	0.18	3393	0.03	115	0.025	137	0	\$0.00	YES	\$65.11	NO	\$0.00
76	1.69	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Photolab	1.25	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
93	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
97	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Microlab	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	2.48	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Chem.Rr	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
91	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
78	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
108	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
107	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
109	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				1745.122								
										\$716.21		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

0:15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY:

JW

CHECKED BY:

CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 213

Sheet 2 of 3

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New 1	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
104	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
101	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
105	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
64	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
59	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Footwear	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Laser Rm	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Auto Rm	1.20	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
111	0.28	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
113	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
114	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
116	0.37	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	3.10	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
117	0.74	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
119	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
121	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
122	0.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
123	4.41	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
125	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
127	0.47	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
127	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
128	0.63	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
129	1.05	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
129	1.07	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
103	0.47	3393	0.09	300	0.066	357	0	\$0.00	YES	\$65.11	NO	\$0.00
104	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
102	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
105	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
108	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
109	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
110	0.89	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
112	1.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
115	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
115	0.18	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
118	0.37	3393	0.07	237	0.052	282	0	\$0.00	NO	\$0.00	YES	\$372.00
120	1.40	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
124	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
126	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
129	4.96	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
58	0.37	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
56	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
55	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
Clean-u	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
62	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
				1611.03								
										\$260.44		

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM EEAP STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 213LITE.wk3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-9-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 213

Sheet 3 of 3

% Unnoc. lights: 19%
Gas Increase Factor 2.20E-04 MBtu/kWh
Cooling Factor (Energy) 1.19

Room No.	Total kW/Month Lighting	Hours 'On' Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
52	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
51	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
65	2.48	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
66	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
45	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
48	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
48	7.44	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	1.96	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
42	4.34	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
79	0.53	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
27	0.62	3393	0.12	400	0.088	476	0	\$0.00	NO	\$0.00	YES	\$0.00
30	2.02	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
86	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
34	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
37	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
38	0.93	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00
94	0.18	3393	0.03	119	0.026	141	0	\$0.00	NO	\$0.00	NO	\$0.00
95	20.92	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
96	0.62	3393	0.12	400	0.088	476	0	\$0.00	YES	\$65.11	YES	\$0.00
97	0.09	3393	0.02	57	0.013	68	0	\$0.00	NO	\$0.00	NO	\$0.00
98	0.78	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
99	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
99	1.86	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
100	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
101	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
102	0.09	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
106	0.62	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
107	1.55	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
66	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
46	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
47	0.47	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
71	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
72	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
73	0.31	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
41	0.16	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
39	2.17	3393	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
77	3.57	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
32	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
26	0.93	3393	0.18	600	0.132	713	0	\$0.00	YES	\$65.11	YES	\$0.00
25	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
28	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
29	0.31	3393	0.06	200	0.044	238	0	\$0.00	YES	\$65.11	NO	\$0.00
33	0.47	3393	0.09	300	0.066	357	0	\$0.00	NO	\$0.00	NO	\$0.00
35	0.47	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
90	0.31	3393	0.06	200	0.044	238	0	\$0.00	NO	\$0.00	NO	\$0.00
36	0.78	3393	0.00	0	0.000	0	0	\$0.00	YES	\$65.11	NO	\$0.00
Total	133.2		2.30736	7828.872	1.72235	9316.358	1	\$0.00		\$1,888.19		\$1,116.00
Total \$ Expense = \$3,004.19												

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO: 15-LIGHTING CONTROL

FILE: 935LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

EXIT SIGNS: 8

BUILDING NUMBER: 935

Sheet 1 of 1

Schedule #1 M-F 600 to 2100 S-S 0 to 0
Schedule #2 M-F 0 to 0 S-S 0 to 0

Room No.	# of Fixtures	Fixture Description	On/Off During Survey	Switch Yes/No	Good For Occup. Sensor	No. of Switches	Unocc. Lights On
1	36	400 Watt Incandescent	on	yes	no	1	no
2	6	400 Watt Incandescent	on	yes	no	1	no
3	6	400 Watt Incandescent	on	yes	no	1	no
4	2	4x2-4 lamp fluorescent	on	no	yes	0	yes
5	2	75 Watt Incandescent	on	no	yes	0	yes
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
6	3	4x2-2 lamp fluorescent	on	yes	yes	1	no
8	1	150 Watt Incandescent	on	yes	yes	1	yes
9	9	4x2-2 lamp fluorescent	on	yes	no	2	yes
10	8	150 Watt Incandescent	on	yes	yes	2	yes
2a	3	4x2-2 lamp fluorescent	on	yes	yes	1	yes
11	9	4x2-2 lamp fluorescent	on	yes	yes	2	yes
13	4	200 Watt Incandescent	on	yes	no	1	yes
14	4	4x2-4 lamp fluorescent	on	yes	yes	1	no
15	1	4x2-2 lamp fluorescent	off	yes	no	1	yes
16	3	4x2-2 lamp fluorescent	on	yes	no	2	yes
17	30	4x2-2 lamp fluorescent	on	yes	no	3	no
18	15	4x2-2 lamp fluorescent	off	yes	yes	3	no
19	10	4x2-2 lamp fluorescent	off	yes	yes	2	no

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

EMC PROJECT: #3105.000

DATE: 22-Apr-92

ECO:15-LIGHTING CONTROL

FILE: 935LITE.WK3

PREPARED BY: JW

CHECKED BY: CEL

CLIENT CONTRACT NO: DACA21-91-C-0097

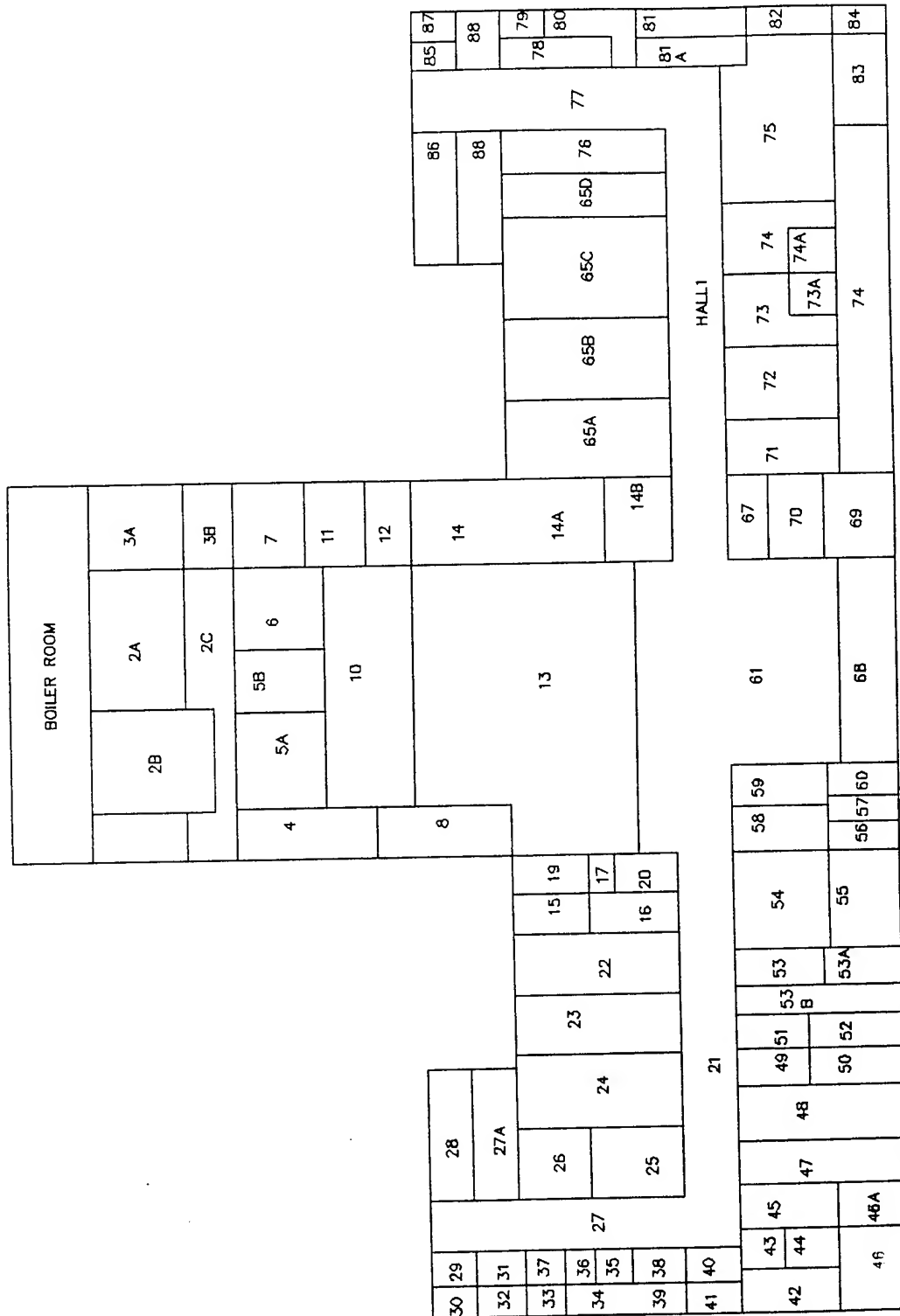
CLIENT PROJECT ENG: TERRY SEABROOK

BUILDING NUMBER: 935

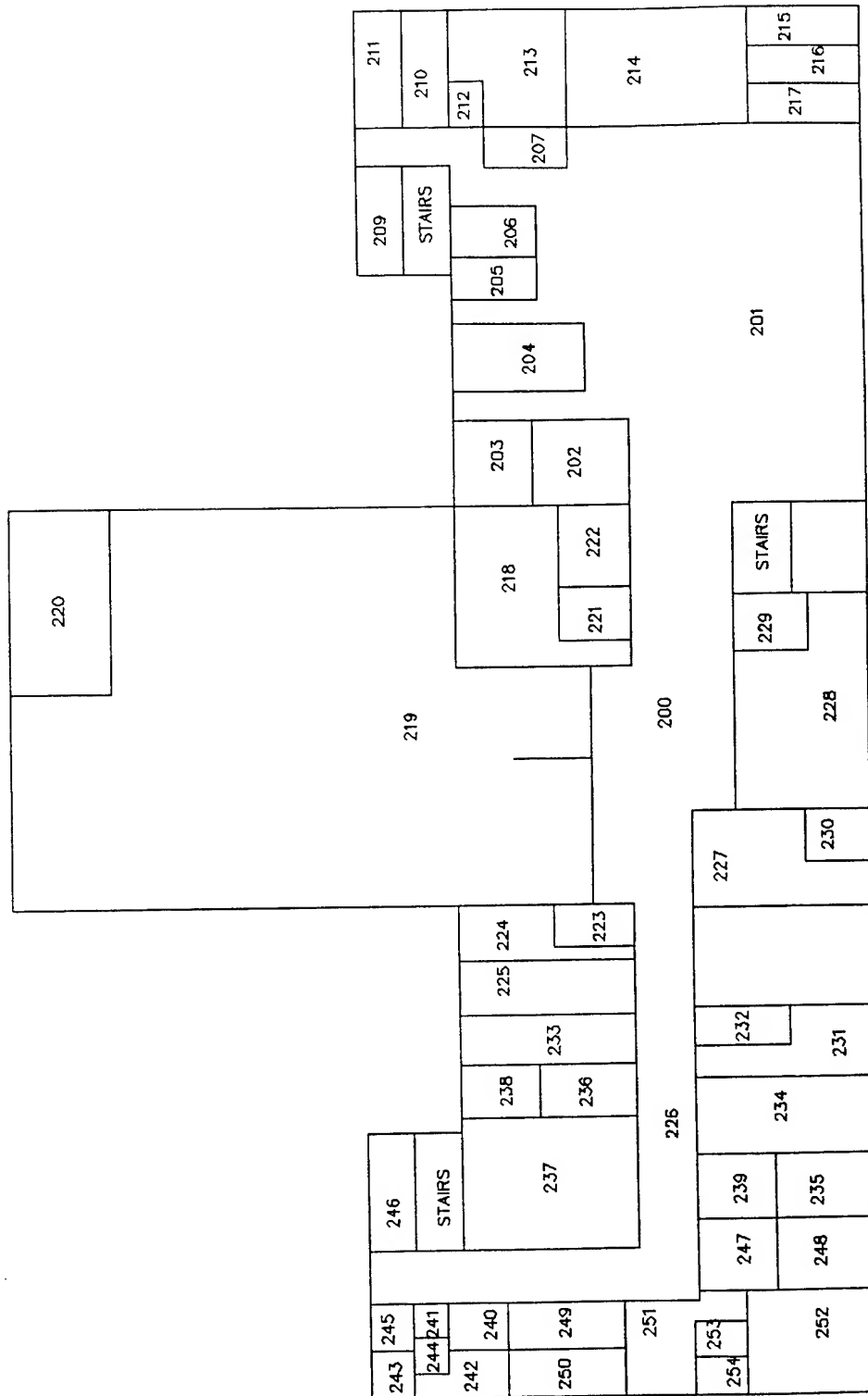
Sheet 1 of 1

% Unnoc. lights: 19%
Gas Increase Factor 1.27E-03 MBtu/kWh
Cooling Factor (Energy) 1.3375

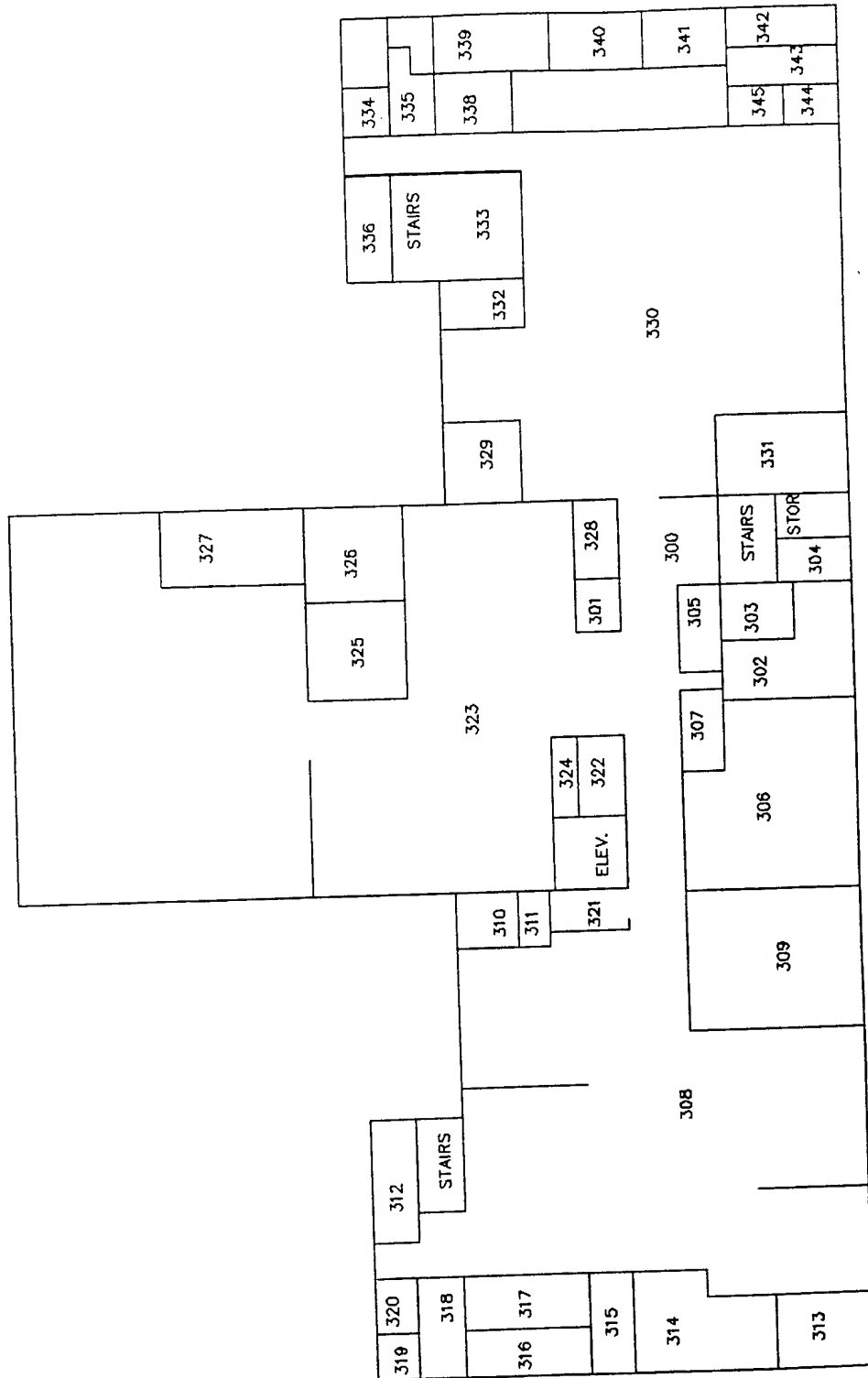
Room No.	Total kW/Month Lighting	Hours "On" Per Year	Lighting kW/Month Saved	Lighting kWh Saved/Yr	Total Gas Increase (MBtu)/yr	Total kWh Saved/Yr	Cost of Switches					
							No. of New Switches	New Switches Cost	Suitable for Wall Sensor	Wall Sensor Cost	Suitable for Ceiling Sensor	Ceiling Sensor Cost
1	14.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
2	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
3	2.40	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
4	0.31	3915	0.06	81	0.102	108	1	\$396.17	YES	\$65.11	NO	\$0.00
5	0.15	3915	0.03	39	0.050	52	1	\$396.17	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
6	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
8	0.15	3915	0.03	112	0.142	149	0	\$0.00	YES	\$65.11	NO	\$0.00
9	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
10	1.20	3915	0.23	893	1.134	1194	0	\$0.00	NO	\$0.00	YES	\$372.00
2a	0.27	3915	0.05	199	0.252	266	0	\$0.00	YES	\$65.11	NO	\$0.00
11	0.80	3915	0.15	596	0.757	797	0	\$0.00	NO	\$0.00	YES	\$372.00
13	0.80	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
14	0.62	3915	0.12	461	0.586	617	0	\$0.00	NO	\$0.00	YES	\$372.00
15	0.09	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
16	0.27	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
17	2.67	3915	0.00	0	0.000	0	0	\$0.00	NO	\$0.00	NO	\$0.00
18	1.34	3915	0.25	993	1.261	1328	0	\$0.00	NO	\$0.00	YES	\$372.00
19	0.89	3915	0.17	662	0.841	885	0	\$0.00	NO	\$0.00	YES	\$372.00
Total	30.351		1.23956	4630.306	5.88049	6193.035	2	\$792.34		\$455.77		\$1,860.00
Total \$ Expense = \$3,108.11												



FIRST FLOOR
NTS

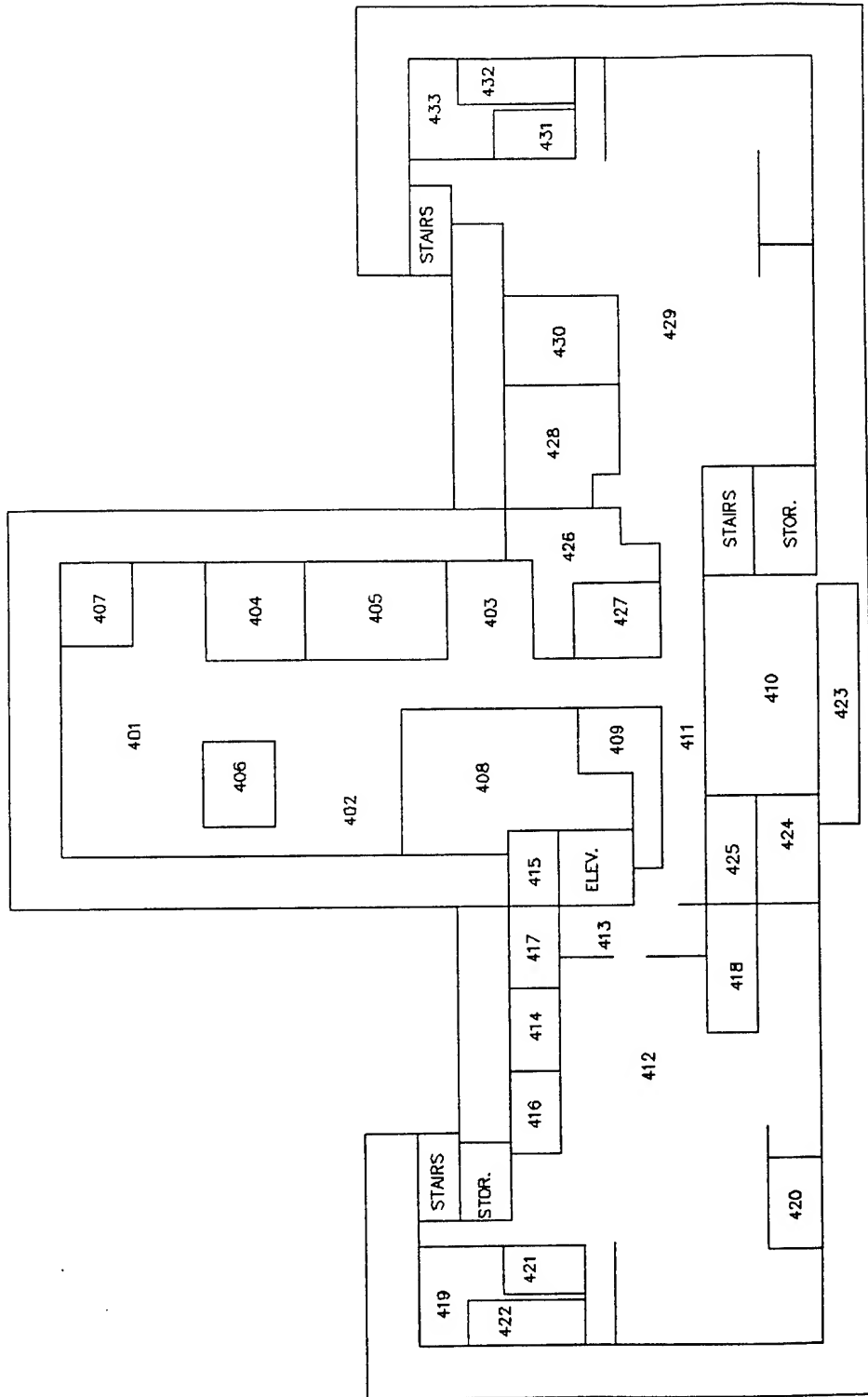


SECOND FLOOR
NTS

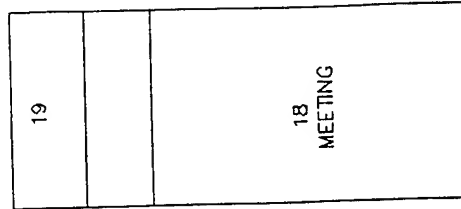
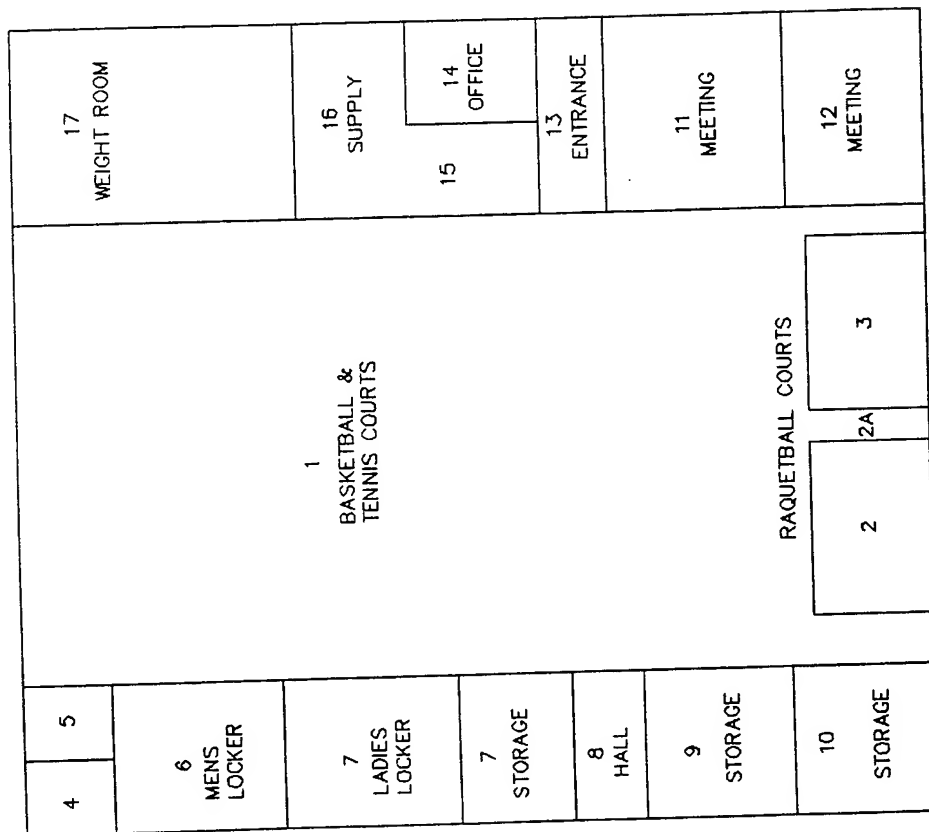


THIRD FLOOR
 NTS

[G101_3rd.dwg]



FOURTH FLOOR
NTS



SECOND FLOOR
NTS

FLOOR PLAN
NTS

[935.DWG]

ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BULB KITS

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-18A EXIT SIGN

ANALYSIS DATE: 07-16-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	9234.
B. SIOH	\$	508.
C. DESIGN COST	\$	554.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	10296.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	218.	\$ 1629.	15.61	25425.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		218.	\$ 1629.		\$ 25425.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	15.
(1) DISCOUNT FACTOR (TABLE A)	14.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	211.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)		\$ 211.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	8390.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS \text{ ECONOMIC LIFE}))$ \$ 1643.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 25636.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.49
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) $SPB=1E/4$ 6.27

**REPLACE EXIT SIGN BULBS SAMPLE CALCULATION, ECO #18
BUILDING 41**

Given:

# of Exit Signs	= 4 signs	- from field survey
Existing Bulb Wattage	= 40 Watts	- from field survey
Improved Bulb Wattage	= 10 Watts	- from manufacturer's data
Gas Cost	= \$4.67 / MBtu	- from utility rate analysis
Electric Cost	= \$0.0255 / kWh	- from utility rate analysis
Demand Cost	= \$8.85 / kW	- from utility rate analysis

Existing Energy Usage:

$$(4 \text{ signs}) * (40 \text{ Watts / sign}) = 160 \text{ Watts}$$
$$(0.16 \text{ kW}) * (8,760 \text{ hrs / yr}) = 1,402 \text{ kWh}$$

Improved Energy Usage:

$$(4 \text{ signs}) * (10 \text{ Watts / sign}) = 40 \text{ Watts}$$
$$(0.04 \text{ kW}) * (8,760 \text{ hrs / yr}) = 350 \text{ kWh}$$

Peak Demand Savings:

$$(0.16 - 0.04 \text{ kW}) = 0.12 \text{ kW}$$

Annual Energy Savings:

- Electric:	(1,402 - 350 kWh)	= 1,052 kWh
- Gas:		= 0 MBtu

Annual Energy Cost Savings:

$$(0 \text{ MBtu}) * (\$4.67 / \text{MBtu}) + (1,052 \text{ kWh}) * (\$0.0255 / \text{kWh}) + (0.12 \text{ kW}) * (\$8.85 / \text{kW}) * (4 + .95 * 8) = \$39 / \text{yr}$$

Annual Increased recurring cost

$$(\$7.95) - (2 * \$2.25) * (8,769 \text{ yr} / 10,000 \text{ hr}) = \$3.02 / \text{yr} / \text{fixture}$$
$$4 \text{ fixtures} = 4 * \$3.02 = \$12.08 / \text{yr}$$

Estimated Construction Cost:

$$\$38.00 / \text{sign} - \text{from engineer's cost estimate}$$

$$(\$38.00 / \text{sign}) * (4 \text{ sign}) = \$152$$

$$\$152 + (\$152 * .055 \text{ SIOH}) + (\$152 * .06 \text{ DESIGN}) = \$169$$

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: REPLACE EXIT SIGN LIGHTING WITH FLUORESCENT LIGHT RETROFIT KIT

EMC PROJECT: #3105.000

DATE: 07/15/92

FILE: GEXITLIT.WK3

PREPARED BY: CAMERAN DIBAI

CLIENT CONTRACT NO: DACA21-91-C-0097

CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST	\$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST	\$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE	\$102.66 kW	14.53 UPW
ECONOMIC LIFE	25 YRS	
ESTIMATED 8760 HOURS OF EXIT LIGHTING PER YEAR		

BLDG	NUMBER OF FIXTURES	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENERG SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
G101	70	2.1	18396	0	63	\$471	\$216	(\$211.40)	\$475	\$2,966	2.5	6.2
103	9	0.27	2365.2	0	8	\$61	\$28	(\$27.18)	\$61	\$381	2.5	6.2
207	48	1.44	12614.4	0	43	\$323	\$148	(\$144.96)	\$326	\$2,034	2.5	6.2
213	48	1.2	10512	0	36	\$269	\$123	(\$120.80)	\$271	\$1,695	2.5	6.2
G400	48	1.44	12614.4	0	43	\$323	\$148	(\$144.96)	\$326	\$2,034	2.5	6.2
G401	20	0.6	5256	0	18	\$135	\$62	(\$60.40)	\$136	\$847	2.5	6.2
935	8	0.24	2102.4	0	7	\$54	\$25	(\$24.16)	\$54	\$339	2.5	6.2
TOTAL	243	7.29	63860.4	0	217.956	1634.83	748.39	-733.86	1649.4	\$10,296	2.5	6.2

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study

LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

☒ CODE A ☐ CODE B ☐ CODE C

☐ OTHER

DATE PREPARED

22-Apr-92

SHT OF

EFFECTIVE PRICING

DATE APR 92

DRAWING NO.

CHECKED BY CEL

SHIPPING

ESTIMATOR RMG

TOTAL

MATERIAL

EQUIPMENT

LABOR

Quantity

No. Of Units

Unit Meas

MH/ Unit

Total Hrs

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

Unit Price

Cost

TASK DESCRIPTION

EXIT SIGN RETROFIT KIT

SUBTOTAL

OVERHEAD, BOND

PROFIT

COST SUB-TOTAL

CONTINGENCY

TOTAL

DA FORM 5418-R, APR 85

ECO-11, REPLACE STREET LIGHTS

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO25

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-11 RPLACE STREET LIGHTS

ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	2405.
B. SIOH	\$	133.
C. DESIGN COST	\$	145.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	2683.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	17.	\$ 126.	15.61	1962.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		17.	\$ 126.		\$ 1962.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	14.53	\$ 174.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$ 2528.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ 2528.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 647.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .97

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 300.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 4490.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.67

(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 8.95

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
ECO-11: REPLACE EXTERIOR LIGHTING

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
DATE: 09/01/92
FILE: EXT LITES.WK3
PREPARED BY: JIM WATTERS
CHECKED BY:

ENERGY COST	DISCOUNT FACTOR
INCREMENTAL GAS COST \$4.67 MBtu	23.77 UPWG
INCREMENTAL ELECTRIC COST \$0.0256 kWh	15.61 UPWE
ELECTRIC DEMAND CHARGE \$102.66 kW	14.53 UPW

25 YRS

ESTIMATED 3285 HOURS OF EXTERIOR LIGHTING PER YEAR

Existing Bulb Wattage (WATTS)	Existing Bulb Type	Number of Bulbs	Replacement Bulb Wattage (WATTS)	Replacement Bulb Type	ANNUAL DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh)	ANNUAL NAT GAS SAVINGS (MBtu)	TOTAL ENERGY SAVINGS (MBtu)	ANNUAL ENERGY SAVINGS (\$)	ANNUAL DEMAND SAVINGS (\$)	ANNUAL NON-ENERG SAVINGS (\$)	TOTAL ANNUAL SAVINGS (\$)	CONST. COST (\$)	SIR	SIMPLE PAYBACK (YRS)
1500	QUARTS	0	400	HPS*	0	0	0	0	\$0	\$0	\$0	\$0	\$0		
500	QUARTS	5	200	HPS*	0	4927.5	0	17	\$126	\$0	\$174	\$300	\$2,682	1.7	8.9
400	MERCURY	2	360	HPS	0	262.8	0	1	\$7	\$0	\$0	\$7	\$176	0.6	26.2
175	MERCURY	122	150	HPS	0	10019.3	0	34	\$256	\$0	\$0	\$256	\$9,114	0.4	35.5

COST ESTIMATE ANALYSIS

PROJECT Ft. McPherson & Ft. Gillem ESOS Study
LOCATION Ft. McPherson & Ft. Gillem

INVITATION NO./CONTRACT NO.

DACA 21-91-C-0097

X CODE A CODE B CODE C
OTHER

EFFECTIVE PRICING

DATE APR 92

DRAWING NO.

DATE PREPARED

22-Apr-92

SHT OF

CHECKED BY CEL

ESTIMATOR RMG

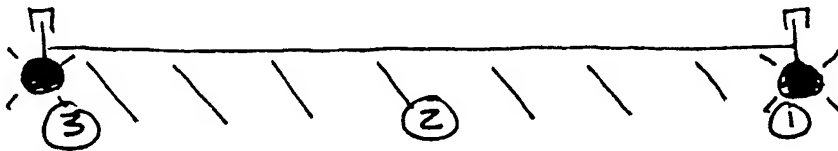
EXTERIOR LIGHTING TASK DESCRIPTION	Quantity		LABOR		EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	No. Of Units	Unit Meas	MH/ Unit	Total Hrs	Unit Price	Cost	Unit Price	Cost		Unit Wt	Total Wt
400 W HPS LAMP w/ FIXTURE	1	EA	4	4	\$21.17	\$84.68	\$275.00	\$275.00	\$359.68		
OVERHEAD, BOND	15%					\$12.70		\$41.25	\$53.95		
PROFIT	10%					\$8.47		\$27.50	\$35.97		
COST SUB - TOTAL						\$105.85		\$343.75	\$449.60		
CONTINGENCY	15%					\$15.88		\$51.56	\$67.44		
TOTAL						\$121.73		\$395.31	\$517.04		
200 W HPS LAMP w/ FIXTURE	1	EA	4	4	\$21.17	\$84.68	\$250.00	\$250.00	\$334.68		
OVERHEAD, BOND	15%					\$12.70		\$37.50	\$50.20		
PROFIT	10%					\$8.47		\$25.00	\$33.47		
COST SUB - TOTAL						\$105.85		\$312.50	\$418.35		
CONTINGENCY	15%					\$15.88		\$46.88	\$62.75		
TOTAL						\$121.73		\$359.38	\$481.10		
360 W HPS LAMP	1	EA	1	1	\$21.17	\$21.17	35	\$35.00	\$56.17		
OVERHEAD, BOND	15%					\$3.18		\$5.25	\$8.43		
PROFIT	10%					\$2.12		\$3.50	\$5.62		
COST SUB - TOTAL						\$26.46		\$43.75	\$70.21		
CONTINGENCY	15%					\$3.97		\$6.56	\$10.53		
TOTAL						\$30.43		\$50.31	\$80.74		
150 W HPS LAMP	1	EA	1	1	\$21.17	\$21.17	25	\$25.00	\$46.17		
OVERHEAD, BOND	15%					\$3.18		\$3.75	\$6.93		
PROFIT	10%					\$2.12		\$2.50	\$4.62		
COST SUB - TOTAL						\$26.46		\$31.25	\$57.71		
CONTINGENCY	15%					\$3.97		\$4.69	\$8.66		
TOTAL						\$30.43		\$35.94	\$66.37		

JOB FI. McPHERSON / GILLEM
 EMC # 3105.000
 SHEET NO. _____ OF _____
 CALCULATED BY CEL DATE 7/21/92
 CHECKED BY _____ DATE _____
 SCALE _____

E M C ENGINEERS, INC.

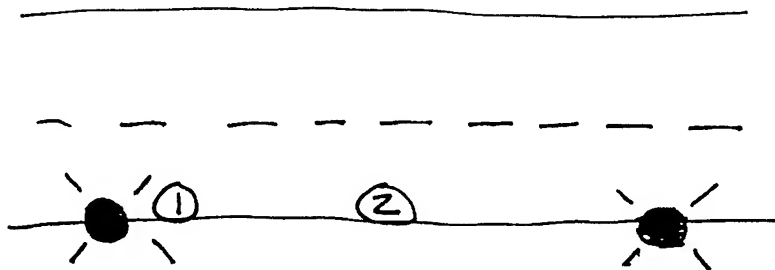
Denver • Colorado Springs • Atlanta • Germany

**STREET LIGHT READINGS
 PARKING LOT BEHIND B.200**



①	—	2.07	FOOTCANDLES
②	—	0.35	"
③	—	2.10	"
④	—	0.37	"
⑤	—	0.10	"
⑥	—	0.35	"

STREET BEHIND PX



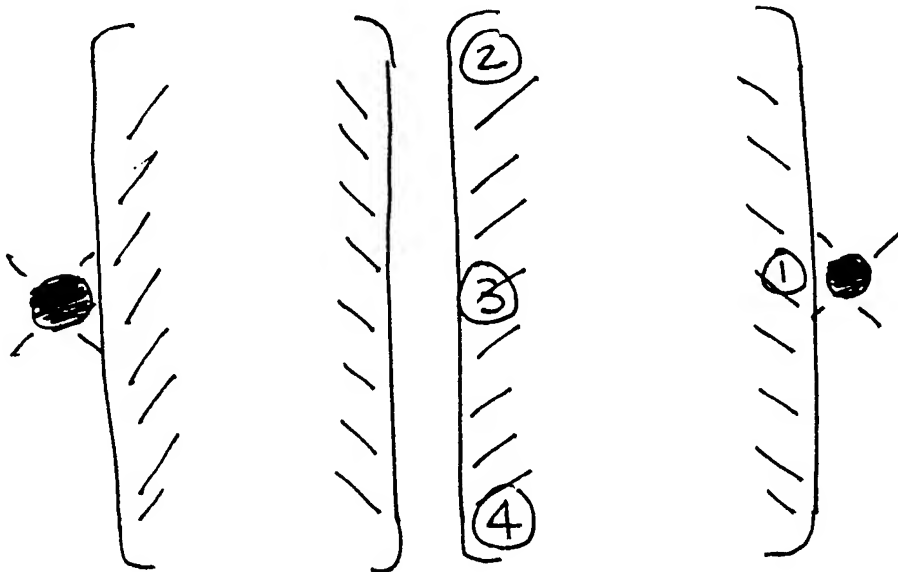
①	3.7	FOOTCANDLES
②	1.2	"

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JOB FT. McPHERSON / GILLEM
SHEET NO. EMC# 3105,000 OF
CALCULATED BY CEJ DATE 7/21/92
CHECKED BY DATE
SCALE

**STREET LIGHT READINGS
PARKING LOT IN FRONT OF B 200**



①	—	2.07	FOOTCANDIES
②	—	0.17	"
③	—	0.33	"
④	—	0.03	"

CROSS WALK IN FRONT OF BLDG 200

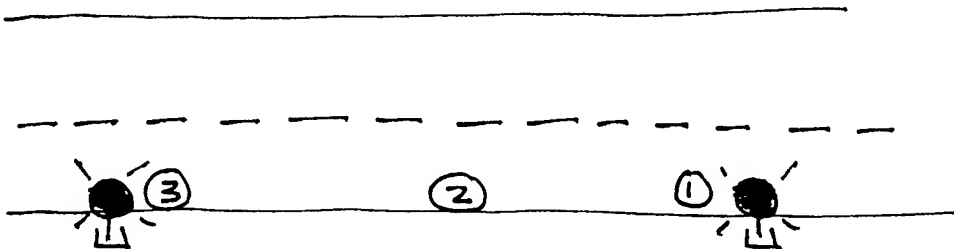
0.80 FOOTCANDIES

JOB FT. McPHERSON / GILLEM
EMC # 3105,000
 SHEET NO _____ OF _____
 CALCULATED BY CEL DATE 7/21/92
 CHECKED BY _____ DATE _____
 SCALE _____

E M C ENGINEERS, INC.
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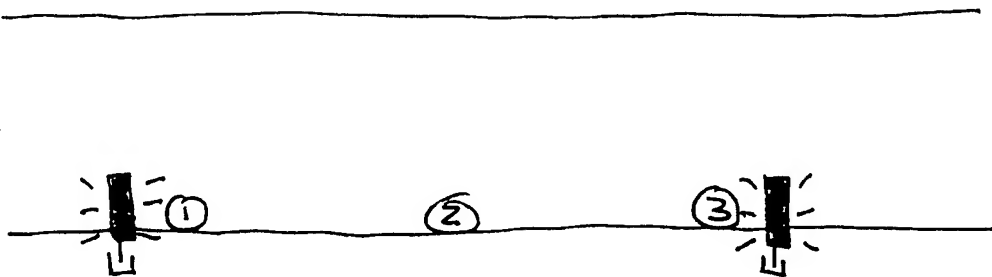
STREET LIGHT READINGS

STREET IN FRONT OF B, 200



①	—	3, 4	FOOTCANDLES
②	—	0, 13	"
③	—	3, 4	"

STREET IN FRONT OF B, 168



①	—	0.17	FOOTCANDLES
②	—	0.09	"
③	—	0.18	"

E M C ENGINEERS, INC.

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JOB FT. McPHERSON / GILLEM

EMC # 3105,000

SHEET NO. _____ OF _____

CALCULATED BY CEL

DATE 7/21/92

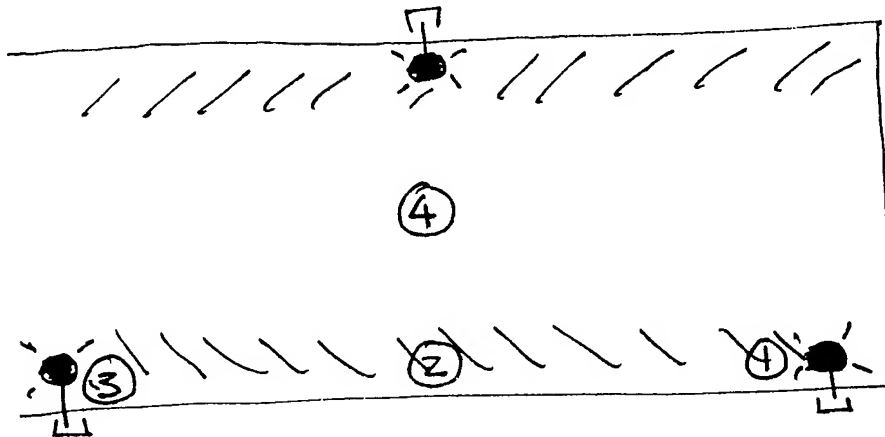
CHECKED BY _____ DATE _____

SCALE _____

STREET LIGHT READINGS

BLDG

PARKING LOT



①	—	2.47	FOOTCANDLES
②	—	0.23	"
③	—	2.33	"
④	—	0.64	"

Fig. 14-18. Recommended Maintained Illuminances for Open and Covered Parking Facilities

Open Parking Facilities								
Level of Activity	For Vehicular Traffic			For Pedestrian Safety		For Pedestrian Security		
	Lux*	Footcand-les*	Uniformity Ratio	Lux**	Footcand-les**	Lux*	Footcand-les*	Uniformity Ratio
Low activity	5	0.5	4:1	2	0.2	9	0.8	5:1
Medium activity	11	1	3:1	6	0.6	22	2	5:1
High activity	22	2	3:1	10	0.9	43	4	5:1

Covered Parking Facilities				
Areas	Day		Night	
	Lux***	Footcandles***	Lux*	Footcandles*
General parking and pedestrian areas	54	5	54	5
Ramps and corners	110	10	54	5
Entrance areas	540	50	54	5
Stairways and lobbies (refer to Fig. 2-2)				

* Average on pavement

** Minimum on pavement

*** Average on payment—sum of electric lighting and daylight

the "High" activity lighting levels may be required, but while the game is being played or during hours of reduced activity the "Medium" or "Low" activity lighting levels may be adequate.

ROADWAY ILLUMINATION DATA AND CALCULATIONS

The following is an example of a simple and straightforward calculation procedure to determine average illuminance and luminance at a specific point on a roadway. For a detailed treatment of the subject, including calculations for high-mast and pedestrian walkway lighting, the reader is referred to Reference 1.

Determination of Average Illuminance

The average illuminance over a large pavement area in terms of lux (footcandles) may be calculated by means of a "utilization curve" of the type shown in Fig. 14-19.

Utilization Curves. Utilization curves, available for various types of luminaires, afford a practical method for the determination of average illuminance over the roadway surface where lamp size, mounting heights, width of roadway, overhang and spacing between luminaires are known or assumed. Conversely, the desired spac-

ing or any other unknown factor may readily be determined if the other factors are given.

The Coefficient of Utilization, as shown in Fig. 14-19, is the percentage of rated lamp lumens which will fall on either of two strip-like areas of infinite length, one extending in front of the luminaire (street side), and the other behind the luminaire (house side), when the luminaire is level and oriented over the roadway in a manner equivalent to that in which it was tested. Since roadway width is expressed in terms of a ratio of luminaire mounting height to roadway width, the term has no dimensions.

Light Loss Factors. There are a number of causes of light loss. They are listed on page 4-21. For each cause, a factor can be determined. All individual factors can be multiplied together to obtain one total light loss factor. Some factors, usually due to less than ideal operating conditions, exist initially and continue through the life of the installation. They may, however, have too little effect to justify correction or be too costly to correct. The significant light loss factors in roadway calculations are:

Lamp Lumen Depreciation. Information about lamp lumen depreciation is available from manufacturers' tables and graphs for lumen depreciation and mortality of the chosen lamp. Rated average life should be determined for the specific hours per start; it should be known when burnouts will begin in the lamp life cycle. From these facts, a practical group relamping cycle will be established and then, based on the hours elapsed to lamp removal, the specific lamp lumen depreciation (LLD) factor can be determined.

APPENDIX D-2 MCA PROJECT 2

ECO-19, PREVIOUS LIGHTING REVIEW STUDY, FOR LIGHT FIXTURE
REPLACEMENTS

LIFE CYCLE COST ANALYSIS SUMMARY
 ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) STUDY: GECO25
 LCCID 1.062
 INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3
 PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY
 FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-19 LIGHT RETROFIT
 ANALYSIS DATE: 07-17-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	2135242.
B. SIOH	\$	117439.
C. DESIGN COST	\$	128115.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	2380796.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	10143.	\$ 75781.	15.61	1182934.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	0.	\$ 0.	23.77	0.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		10143.	\$ 75781.		\$ 1182934.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	130378.
(1) DISCOUNT FACTOR (TABLE A)	14.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	1894392.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	1894392.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 390368.
 A IF 3D1 IS = OR > 3C GO TO ITEM 4
 B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .66
 C IF 3D1B IS = > 1 GO TO ITEM 4
 D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))\$ 206159.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 3077327.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.29
 (IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.55

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 19 - PNL Lights

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-19.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

	ENERGY COST	DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG
Electric Savings	\$0.0255 / kWh	15.61 UPWE
Demand Savings	\$8.85 / kW	14.53 UPW
Economic Life: 15 yrs		

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON- ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
Office	483	1,130,220	0	3,854	\$28,821	\$49,585	\$0	\$78,405	\$854,105	1.4	10.9
Warehouse	787	1,841,580	0	6,280	\$46,960	\$80,793	\$0	\$127,754	\$1,526,690	1.2	12.0
TOTAL	1,270	2,971,800	0	10,134	75,781	130,378	0	206,159	2,380,795	1.3	11.5

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

LOCATION: FORT GILLEM

ECO: 19 – PNL Lights

CLIENT CONTRACT NO: DACA21 –9 –C –0097

CLIENT PROJECT ENG: TERRY SEABROOK

Operation: 2340 hrs / yr

EMC PROJECT: #3105.000

DATE: 2 –APR –92

FILE: ECO –19.WK3

PREPARED BY: R. GERRANS

CHECKED BY:

Bldg. Type	Exist Demand (kW)	Imprvd Demand (kW)	Cooling Demand Savings (kW)	Demand Savings (kW)	Electric Usage Savings (kWh/yr)	Installation Cost (\$)
Warehouse	1,705	918	0	787	1,841,580	\$1,369,229
Office	1,201	718	0	483	1,130,220	\$766,014

TRI-SERVICE MILITARY CONSTRUCTION PROGRAM (MCP) INDEX

CALENDAR YEAR	*1990	*1991	1992	1993	1994	1995	1996
JANUARY	1676	1742	1810	1875	1938	1999	
FEBRUARY	1679	1746	1813	1878	1941	2002	
MARCH	1682	1750	1816	1881	1944	2005	
APRIL	1686	1753	1819	1885	1947	2009	
MAY	1693	1760	1826	1891	1953	2015	
JUNE	1700	1767	1833	1897	1959	2021	
JULY	1706	1773	1839	1904	1966	2027	
AUGUST	1713	1780	1846	1910	1972	2033	
SEPTEMBER	1720	1787	1853	1916	1978	2039	
OCTOBER	1726	1793	1859	1922	1984	2045	
NOVEMBER	1731	1799	1864	1927	1981		
DECEMBER	1736	1805	1869	1932	1990		

Example: (For 10 Month Construction Period)

Submittal Date	- 1 Sept 90	1720	-- 13 Months
Bid Opening Date	- 1 Apr 91		
Contract Award Date	- 1 May 91		
Midpoint of Construction	- 1 Oct 91	1793	

Cost Growth Factor = $1793 / 1720 = 1.0424$ Use 1.04

Use 4 % Per Fiscal Year For Projection Beyond FY 1997

* Historical

Cost Escalation

Report Date: 12/89 (use 1/90)
Present Date 4/92

MCP Index

1676
1819

Cost Growth Factor = $1819 / 1676 = 1.0853$ use 1.09

**FEASIBILITY STUDY FOR
LIGHTING SHARED ENERGY SAVINGS PROJECT
FORT McPHERSON AND FORT GILLEM, GEORGIA**

U.S. Army Corps of Engineers
Huntsville Division

Contract DACA87-89-D-0007
Delivery Order 0005

FINAL REPORT

July 20, 1990

The fixtures in the Generals' offices, Rooms 333, 336, and 339, should be changed to a 2 x 4 or a 2 x 2 louvered fixture the same style as Item 1. By installing fixtures as specified in Item 1, a maintained foot candle level of 60 FC will result, yielding a 78 percent reduction in wattage in comparison to the existing incandescent system estimated wattage of 7 kW. Installation costs are estimated at \$1,608. The fixtures can be connected to two fluorescent dimming circuits to provide full control of the lighting level. Simple payback based on energy savings will be 3 years. Increased maintenance savings not included will shorten payback period.

The basement level or any areas without any artificial lighting could have a minimum number of fixtures powered by a battery system or by the building UPS system to provide continuous lighting during generator startup, (limited to 10 seconds by life safety codes), thus eliminating the interruption of critical operations due to a utility failure.

Exit signs with incandescent lamps should be replaced or retrofitted with fluorescent lamps which will give a lighting wattage reduction of 80 percent from an estimated load of 3 kW, and an increase in light output of over 65 percent. The installation cost is estimated at \$2,220. The use of a Liquid Crystal Display (LCD) type is not recommended since LCD signs do not provide sufficient illumination to be visible during a fire emergency evacuation. Simple payback based on energy savings will be 1.5 years. Increased maintenance savings not included will shorten payback period.

3.7 CAPITAL COST ESTIMATE

3.7.1 Warehouse

The 11,100 existing fluorescent fixtures in use will be replaced with 4,964 High Pressure Sodium (HPS) fixtures at a cost of \$1,255,900 (in 12/89 dollars). This does not include \$273,000 for rewiring from 120 V to 277 V believed necessary for the warehouses because of the age and condition of the existing 120 V wiring. Because this rewiring should be done by the government anyway, we have assumed that it would be done by separate contract and should not be reflected in the SES analysis of potential costs and

benefits. Including the cost of rewiring will make it harder for the Third Party Contractor to meet his economic goals with the Shared Energy Savings Contract. However, the effect of rewiring on the gross payback will be included in Section 5. The unit cost of installing new HPS fixtures is \$253/fixture. This includes the cost of the luminaire and lamp, and the cost of labor at \$25/hr. The equipment cost is based on discussions with potential vendors.

The cost estimate is based on replacing the fixtures at Fort Gillem. Fort McPherson warehouses, although likely to be included in any retrofit program, contain only 5 percent of the total number of fixtures and was not included in the evaluation.

3.7.2 Office

The existing fluorescent fixtures will be replaced with parabolic louvered fixtures with energy-saving lamps and ballast arrangements. The cost will be \$1,294,120 for both Fort Gillem (\$702,765) and Fort McPherson (\$591,355 including \$244,483 for CCF), including the Command and Control Facility. Unlike the warehouses, no supply rewiring is required.

3.8 MAINTENANCE COST ESTIMATE

3.8.1 Warehouse

The cost of yearly maintenance for HPS fixtures is based on group relamping at 75 percent of the lamp life. The procedure is similar to that described in Section 3.4. Maintenance includes the material and labor necessary to replace and clean lamps and to replace ballasts. Material costs are based on discussions with vendors. The average annual cost of maintaining the fixtures is \$53,611.

SECTION 4

ENERGY COMPARISON

The lighting retrofit programs described in Section 3.5 for offices and warehouses offer significant energy savings. In the offices, switching to parabolic louvered fixtures and energy saving magnetic ballasts will result in the following:

	<u>Fort Gillem</u>	<u>Fort McPherson</u>	<u>Total</u>
Existing load (kW)	1,201	1,217	2,418
Future loads (kW)	<u>718</u>	<u>669</u>	<u>1,387</u>
Savings (kW)	483	548	1,031
Percent savings			43%

In the CCF alone, the load will be reduced from 507 kW to 255 kW, a reduction of 50 percent.

In Fort Gillem's warehouses, switching to High Pressure Sodium fixtures will reduce the lighting load from 1,705 kW to 918 kW, a reduction of 787 kW or 46 percent.

The savings are based on the energy reduction calculated by system characteristics (connected load and hours of operation) observed in the walkdown, compared to reduction in power of the recommended system.

The power cost savings will not be quite so high in percentage savings because of Georgia Power Company's declining block rate structure. The rates are as follows:

	<u>Incremental Usage (kWh)</u>	<u>Rate (\$/kWh)</u>
<u><300 hr/mo * Billing Demand:</u>	50,000	0.05710
(up to maximum of	150,000	0.05590
1,961,500 kWh)	800,000	0.04150
	961,400	0.03950
<u>>300 hr/mo * Billing Demand:</u>	Balance of kWh	0.01110

In addition, a fuel charge of \$0.016045 is charged for every kWh of usage.

The lighting systems are assumed to be in use 9 hours/day, 5 days/week or an average of 195 hours/month.

Table 4-1 presents the existing and future power charges for all of the offices including the Command and Control Facility and for the CCF separately. Note that the average rate increases with the modification because a greater percentage of the power usage is shifted to the higher rates. The total bill for all office lighting, however, is reduced by 45 percent and for the CCF alone, by 50 percent. In addition to the power savings due to lighting system changes in the CCF, there will be a net decrease in power consumed for air conditioning. The CCF is cooled by a motor-driven chiller. The differential energy consumption was determined by modeling the building and HVAC system both before and after the proposed modification. The total annual energy reduction, including the effects on heating, is 184,552 kWh/yr. The HVAC load reduction of other buildings was not calculated because due to system sizes and usage patterns the energy reduction will be small compared to lighting energy reduction.

The energy cost savings may be overstated due to electric loads other than lighting. These additional loads will generally be unaffected by the proposed lighting system changes and therefore, reductions in lighting system loads may occur in lower rate blocks. The approach used is more optimistic for the value of savings.

The warehouse power charges are presented on Table 4-2. The average rate will increase from \$0.066/kWh to \$0.072 kWh, but the total bill will be reduced by 41 percent.

TABLE 4-1

OFFICE (ALL) POWER COST

Monthly Energy Rate which Includes Demand			Existing System		Modified System	
Hr/Mo	Incr. kWh	Rate	Avg. 471,534 kWh/Mo kWh	Cost	Avg. 270,314 kWh/Mo kWh	Cost
<300	50,000	\$0.0571	50,000	\$ 2,855	50,000	\$ 2,855
	150,000	0.0559	150,000	8,385	150,000	8,385
	800,000	0.0415	271,534	11,269	70,314	2,918
	961,000	0.0395	0	0	0	0
>300	(Balance)	0.0111	0	0	0	0
Fuel	All kWh	0.016045	471,534	7,566	270,314	\$ 4,337
				\$30,074		\$18,495
			Avg. Rate	\$0.064/kWh		\$0.068/kWh

COMMAND AND CONTROL FACILITY POWER COST

Existing System				Modified System		
	kWh	@ Avg. rate from above	Cost	kWh	@ Avg. rate from above	Cost
Lighting Costs:	98,865	\$0.064/kWh	\$6,327	49,725	\$0.068/kWh	\$3,381
Differential Air Cond. Costs:	Base		base -15,379 \$6,327	0.068		-1,046 \$2,335

$$A/C \text{ Demand Savings} = 15,379 \text{ kWh} / (195 \text{ hrs/mo}) = \boxed{79} \text{ kW}$$

APPENDIX D-3 LOW-COST OR NO-COST ECO
ECO-8, INSTALL LOW-FLOW SHOWER AND FAUCET FIXTURES

LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GECO15

LCCID 1.062

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

INSTALLATION & LOCATION: FT. GILLEM REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: ECO-8 WATER FLOW RESTRICTORS

ANALYSIS DATE: 07-15-92 ECONOMIC LIFE 15 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	830.
B. SIOH	\$	46.
C. DESIGN COST	\$	50.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	926.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	0.	\$ 0.	11.11	0.
B. DIST	\$.00	0.	\$ 0.	14.26	0.
C. RESID	\$.00	0.	\$ 0.	16.89	0.
D. NAT G	\$ 4.67	99.	\$ 462.	14.45	6681.
E. COAL	\$.00	0.	\$ 0.	11.21	0.
F. TOTAL		99.	\$ 462.		\$ 6681.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A)	10.59	\$ 550.
(2) DISCOUNTED SAVING/COST (3A X 3A1)		\$ 5825.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) \$ 5825.

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ 2205.

A IF 3D1 IS = OR > 3C GO TO ITEM 4

B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) 9.60

C IF 3D1B IS = > 1 GO TO ITEM 4

D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS \text{ ECONOMIC LIFE}))$ \$ 1012.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 12505.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 13.51

(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) $SPB=1E/4$.91

WATER FLOW RESTRICTORS SAMPLE CALCULATION, ECO #8 BUILDING 60

Given:

# of people	= 48 people	-from field survey
Water heater efficiency	= 70%	-assumed
Gas cost	= \$4.67 / MBtu	-from utility rate analysis
Water Cost	= \$2.39 / 1000 gals	-from utility rate analysis

Showers:

# of showers	= 18 showers	-from field survey
Existing water flow	= 3.75 gpm	-from field survey
Improved water flow	= 1.6 gpm	-from field survey
Usage	= (7 min/person day)*(365 days/year)	
	= 2,555 min/person yr	-assumed
Shower water temperature	= 102°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Faucets:

# of faucets	= 36 faucets	-from field survey
Existing water flow	= 2.25 gpm	-from field survey
Improved water flow	= 0.40 gpm	-from field survey
Usage	= (5 min/person day)*(365 days/year)	
	= 1,825 min/person yr	-assumed
Faucet water temperature	= 80°F	-assumed
Supply water temperature	= 66°F	-from City of Atlanta info

Annual Existing Flow:

Showers:

$$(48 \text{ people}) * (3.75 \text{ gpm}) * (2,555 \text{ min/yr}) = 459,900 \text{ gal/yr}$$

Faucets:

$$(48 \text{ people}) * (2.25 \text{ gpm}) * (1,825 \text{ min/yr}) = 197,100 \text{ gal/yr}$$

Total:

$$459,900 \text{ gal/yr} + 197,100 \text{ gal/yr} = 657,000 \text{ gal/yr}$$

Annual Improved Flow:

Showers:

$$(48 \text{ people}) * (1.6 \text{ gpm}) * (2,555 \text{ min/yr}) = 196,224 \text{ gal/yr}$$

Faucets:

$$(48 \text{ people}) * (0.40 \text{ gpm}) * (1,825 \text{ min/yr}) = 35,040 \text{ gal/yr}$$

Total:

$$196,224 \text{ gal/yr} + 35,040 \text{ gal/yr} = 231,264 \text{ gal/yr}$$

Annual Non-Energy Savings:

Showers:

$$459,900 \text{ gal/yr} - 196,224 \text{ gal/yr} = 263,676 \text{ gal/yr}$$

Faucets:

$$197,100 \text{ gal/yr} - 35,040 \text{ gal/yr} = 162,060 \text{ gal/yr}$$

Total:

$$657,000 \text{ gal/yr} - 231,264 \text{ gal/yr} = 425,736 \text{ gal/yr}$$

Annual Energy Savings:

Showers:

$$(263,676 \text{ gal/yr}) * (8.33 \text{ lbs/gal}) * (1 \text{ Btu/lb } ^\circ\text{F}) * (102^\circ\text{F} - 66^\circ\text{F}) / 70\% \\ = 113.0 \text{ MBtu/yr}$$

Faucets:

$$(162,060 \text{ gal/yr}) * (8.33 \text{ lbs/gal}) * (1 \text{ Btu/lb } ^\circ\text{F}) * (80^\circ\text{F} - 66^\circ\text{F}) / 70\% \\ = 27.0 \text{ MBtu/yr}$$

Total:

$$113 \text{ MBtu/yr} + 27 \text{ MBtu/yr} = 140 \text{ MBtu/yr}$$

Annual Cost Savings

$$(\$4.67/\text{MBtu}) * (140 \text{ MBtu/yr}) + (\$2.39/1000 \text{ gal}) * (425,736 \text{ gal/yr}) \\ = \$1,671/\text{yr}$$

Estimated Construction Cost:

\$31.74/shower

-from engineer's cost estimate

\$17.36/faucet

-from engineer's cost estimate

$$(\$31.74/\text{ea}) * (18 \text{ showers}) + (\$17.36/\text{ea}) * (36 \text{ faucets}) \\ = \$1,196$$

$$\$1,196 + (\$1,196 * .055 \text{ SIOH}) + (\$1,196 * .06 \text{ DESIGN}) = \$1,334$$

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 8 - Water Flow Restrictors
 CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE: 15-Jul-92
 FILE: ECO-8.WK3
 PREPARED BY: R. GERRANS
 CHECKED BY:

ENERGY COST		DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	14.45 UPWG
Electric Savings	\$0.0255 / kWh	11.11 UPWE
Demand Savings	\$8.85 / kW	10.59 UPW
Water Savings	\$2.910 / 1000 gals	10.59 UPW

Economic Life: 15 yrs

BLDG #	PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
G935	0	0	99	99	\$460	\$0	\$550	\$1,010	\$425	29.4	0.4
Include \$500 cost for administration of small contract											
TOTAL	0	0	99	99	\$460	\$0	\$550	\$1,010	\$925	13.5	0.9

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 8 - WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

COST SAVINGS:
 WATER \$2,910 / 1000 gals

EMC PROJECT: #3105.000
 DATE: 22-APR-92
 FILE: ECO8.WK3
 PREPARED BY: CHRIS STANLEY
 CHECKED BY:

SHOWER FLOW RESTRICTORS											
BLDG #	# PEOPLE	# SHOWERS	USAGE / YEAR (min/yr)	EXIST FLOW (gpm)	IMPRVD FLOW (gpm)	EXIST FLOW (gal/yr)	IMPRVD FLOW (gal/yr)	WATER TEMP		# FAUCETS	USAGE / YEAR (min/yr)
								SHOWER (°F)	SUPPLY (°F)		
935	30	12	2555	4.50	1.50	344,925	114,975	102	66		

CLIENT: FORT GILLEM & FORT McPHERSON
 CLIENT CONTRACT NO: DACA21-91-C-0097

ECO: 8 - WATER FLOW RESTRICTORS
 LOCATION: FORT GILLEM
 PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY

CHECKED BY: J. GILLESPIE
 DATE: 7/14/92
 EMC PROJECT: #3105.000

E M C ENGINEERS, INC.

E M C ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
 LOCATION: FORT GILLEM
 ECO: 8 - WATER FLOW RESTRICTORS

CLIENT CONTRACT NO: DACA21-91-C-0097
 CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT: #3105.000
 DATE: 22-APR-92
 FILE: ECO8.WK3
 PREPARED BY: CHRIS STANLEY
 CHECKED BY:

COST SAVINGS:
 WATER \$2.910 / 1000 gals

FAUCET FLOW RESTRICTORS					SAVINGS			COST		
EXIST FLOW (gpm)	IMPRVD FLOW (gpm)	EXIST FLOW (gal/yr)	IMPRVD FLOW (gal/yr)	WATER TEMP FAUCET (°F)	WATER TEMP SUPPLY (°F)	WATER HEATER EFF	GAS SAVED (MBtu/yr)	WATER SAVED (gal/yr)	WATER SAVED (\$/yr)	TOTAL COST (\$)
						70%	98.5	229,950	\$550	\$381
									\$17.36	
									\$31.74	

ECO-14, LOADING DOCK SEALS
ECO-14, RADIANT HEATERS
ECO-18, REPLACE EXIT SIGN BULBS WITH FLUORESCENT BLUB KITS

[illegible]

W. M. C. ENGINEERS, INC.
PHOTOGRAPHY PERSONS FOR OTHERS
MILWAUKEE
TELEPHONE 2-1000
1000 S. 10TH AVE. MILWAUKEE, WIS.
1000 S. 10TH AVE. MILWAUKEE, WIS.

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LIFE CYCLE COST ANALYSIS SUMMARY

STUDY: GNAF

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065

INSTALLATION & LOCATION: FT. GILLEM, NAREGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: DACA21-91-C-0097 ENERGY SAVINGS OPPORTUNITY SURVEY

FISCAL YEAR 1992 DISCRETE PORTION NAME: NAF PROJECTS

ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 25 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	\$	103512.
B. SIOH	\$	5694.
C. DESIGN COST	\$	6211.
D. SALVAGE VALUE COST	-\$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	\$	115417.

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	\$ 7.47	611.	\$ 4562.	15.61	71217.
B. DIST	\$.00	0.	\$ 0.	21.66	0.
C. RESID	\$.00	0.	\$ 0.	26.51	0.
D. NAT G	\$ 4.67	3829.	\$ 17881.	23.77	425042.
E. COAL	\$.00	0.	\$ 0.	16.06	0.
F. TOTAL		4440.	\$ 22444.		\$ 496259.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$	18.
(1) DISCOUNT FACTOR (TABLE A)	14.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$	262.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4)	\$	262.
D. PROJECT NON ENERGY QUALIFICATION TEST		
(1) 25% MAX NON ENERGY CALC (2F5 X .33)	\$	163765.
A IF 3D1 IS = OR > 3C GO TO ITEM 4		
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) _____		
C IF 3D1B IS = > 1 GO TO ITEM 4		
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY		

4. FIRST YEAR DOLLAR SAVINGS $2F3+3A+(3B1D/(YRS\ ECONOMIC\ LIFE))$ \$ 22462.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 496520.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.30
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) $SPB=1E/4$ 5.14

EMC ENGINEERS, INC.

PROJECT: FORT McPHERSON & FORT GILLEM ESOS STUDY
LOCATION: FORT GILLEM
NAF PROJECTS

CLIENT CONTRACT NO: DACA21-91-C-0097
CLIENT PROJECT ENG: TERRY SEABROOK

EMC PROJECT #3105.000
DATE: 02-Sep-82
FILE: ENLNAF.WKS
PREPARED BY: CMD
CHECKED BY: CEL

		ENERGY COST	25-YR DISCOUNT FACTOR	15-YR DISCOUNT FACTOR
Gas Savings	\$4.67 / MBtu	23.77 UPWG	14.45 UPWG	
Electric Savings	\$0.0255 / kWh	15.61 UPWE	11.11 UPWE	
Demand Savings	\$8.85 / kW	14.53 UPW	10.59 UPW	

ECO #	ECONOMIC LIFE (yrs)	BUILDING NUMBER	ANNUAL/ PEAK DEMAND SAVINGS (kW)	ANNUAL ELECTRIC SAVINGS (kWh/yr)	ANNUAL GAS SAVINGS (MBtu/yr)	TOTAL ENERGY SAVINGS (MBtu/yr)	ANNUAL ENERGY SAVINGS (\$/yr)	ANNUAL DEMAND SAVINGS (\$/yr)	ANNUAL NON-ENERGY SAVINGS (\$/yr)	TOTAL ANNUAL SAVINGS (\$/yr)	CONST COST (\$)	SIR	SIMPLE PAYBACK (yrs)
ECO-14 SEALS	15	505	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	506	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	507	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	508	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	509	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	510	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	511	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	512	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	513	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	514	0	10,534	403	439	\$2,151	\$0	\$0	\$2,151	\$10,811	2.8	5.0
	15	214	0	5,267	202	220	\$1,078	\$0	\$0	\$1,078	\$5,406	2.8	5.0
SUBTOTAL ECO-18			0	100,073	3,829	4,170	\$20,433	\$0	\$0	\$20,433	\$102,705	4.5	5.0
	25	505	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	506	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	507	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	508	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	509	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	510	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	511	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	512	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	513	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
	25	514	1	7,884	0	27	\$201	\$92	(\$91)	\$203	\$1,271	2.5	6.3
SUBTOTAL TOTAL			9	78,840	3,829	269	\$2,010	\$924	(\$906)	\$2,028	\$12,711	2.5	6.3
			9	178,913		4,439	\$22,444	\$924	(\$906)	\$22,462	\$115,416	4.3	5.1

SEE APPENDIX C FOR ADDITIONAL CALCULATIONS